A PROSPECTIVE STUDY OF

"FUNCTIONAL OUTCOME OF MEDIAL CONDYLE FRACTURES OF PROXIMAL TIBIA TREATED USING POSTEROMEDIAL LOCKING COMPRESSION PLATE"

Dissertation submitted to

THE TAMILNADU DR.MGR MEDICAL UNIVERSITY

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In partial fulfilment of the regulations for the award of the degree of

M.S (ORTHOPAEDIC SURGERY)

BRANCH II

GOVT. KILPAUK MEDICAL COLLEGE

CHENNAI- 600010

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CERTIFICATE

This is to certify that this dissertation entitled **“FUNCTIONAL OUTCOME OF MEDIAL CONDYLE FRACTURES OF PROXIMAL TIBIA TREATED USING POSTEROMEDIAL LOCKING COMPRESSION PLATE”** is a record of bonafide research work done by **Dr. DURAIRAJ,** Postgraduate student under my guidance and supervision in fulfilment of regulations of the **The Tamilnadu Dr. M. G. R. Medical University** for the award of M. S. Degree Branch II (Orthopaedic Surgery) during the academic period from 2016 to 2019, in the Department of Orthopaedics, Government Royapettah Hospital & Government Kilpauk Medical College, Kilpauk, Chennai- 600010.

Prof. S. SENTHIL KUMAR, M. S. Orth., D. Orth.,
Professor and HOD,
Department of Orthopaedics,
Govt. Royapettah Hospital,
(Govt. Kilpauk Medical College)
Chennai- 600014

Prof. P. VASANTHAMANI M.D, DGO., MNAMS, DCPSY, MBA
The Dean,
Govt. Kilpauk Medical College,
Chennai- 600010

DECLARATION

I, **Dr. Durairaj**, solemnly declare that this dissertation, **"FUNCTIONAL OUTCOME OF MEDIAL CONDYLE FRACTURES OF PROXIMAL TIBIA TREATED USING POSTEROMEDIAL LOCKING COMPRESSION PLATE"** is a bonafide work done by me in the Department of Orthopaedics, Govt. Kilpauk Medical College, Chennai under the guidance of **Prof. S.SENTHIL KUMAR, D.Orth., M.S.Orth.,** Professor and HOD, Department of Orthopaedics, Govt. Royapettah Hospital, Govt. Kilpauk Medical College, Chennai-600010.

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Place: Chennai Signature

Date:

(Dr. Durairaj)

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CONTENTS

INTRODUCTION

INTRODUCTION

Tibial plateau fractures represent a challenge, despite being common in incidence they are difficult to manage since they are mostly associated with soft tissue injuries. They usually occur as a result of high velocity injuries and are common in young age group turning into heavy socioeconomic burden to family. It is not uncommon in old age who have osteopenia and medical comorbidities.

Tibial plateau is one of the most important weight bearing areas of the body with 80% borne by tibia and remaining by fibula. Any fracture in vicinity of the joint is of paramount importance since restoring articular congruity is an essential step for functional outcome. If unaddressed may lead to unstable knee and abnormal forces acting on it. Consequence of which may lead to early osteoarthritis of knee joint. In long term studies it is found that the axial alignment is more important factor rather than articular depression in developing a future osteoarthritis.

It is important to differentiate from pure fracture and fracture dislocation types [1]. Since the latter is associated with high incidence of neurovascular complications and compartment syndrome.

In general tibial plateau fractures are highly demanding in management and also encompasses socioeconomic aspects such as the financial burden, duration of hospital stay, early return to work, etc since it is common in productive age group of the society. Management options include open reduction and internal fixation with plate osteosynthesis; percutaneous screw fixation or external fixation with pin or wire fixators; closed manipulation and casting, especially with a cast brace; staged procedures in the form of external fixators followed by definitive plate osteosynthesis;

traction with early motion; extensile exposure with arthrotomy and reconstruction of the joint surface with plate and screw fixation.

Goals of treatment[2] should include restoration of

- Articular congruity
- Joint alignment
- Stability
- Functional motion.

In an unstable knee with femur abutting the tibia with abnormal biomechanics acting on tibia leads to early osteoarthritis. As the humans have evolved for bipedal life forms, knee pays its price in the form high incidence of osteoarthritis in elderly. The long term functional outcome depends on the above mentioned factors and various modalities have evolved to address the injury with better results.

AIM

AIM

To assess the functional outcome of patients with proximal tibial plateau fractures especially the medial condyle fractures who were treated using posteromedial locking compression plate

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Tibial plateau fractures are managed effectively with improvement in decades over the past 50 years. In the turn of 19^{th} century, they were treated non operatively and many favoured this non-operative management in their studies. More than thousands of studies were published in early 19^{th} century about the management of this capricious joint fracture.

In the early period, proximal tibia fractures were treated with splints and pin tractions. There was increasing trend towards Open reduction and internal fixation from the beginning of the 20^{th} century. Variety of options like internal fixation with anatomical locking plates, cancellous screws and external fixation with ilizarov are available. Choice of the implant depends on the fracture type, associated soft tissue injury and surgeons choice.

In 1900, Open reduction and internal fixation for tibial plateau fracture was first done by Stichbach using silver plates and galvanized steel screws.

In a study by **Apley,** traction of the affected limb and immobilisation for a short period followed by early motion had favourable outcome.

Lasinger et al in his study found out that coronal instability of more than 10 degrees was not favourable for non-operative treatment and results were based on long term followup study.

Dewelius and conoly found that early mobilization was the key for successful clinical outcome and 89% showed good results in their study.

In 1900, Open reduction and internal fixation for tibial plateau fracture was first done by Stichbach using silver plates and galvanized steel screws. **Fesbander** in the year 1901 performed open reduction for tibial plateau fractures. In the later years, Wilms used two nails to hold the reduction.

Sarmiento et al emphasized the role of fibula in tibial plateau fractures. Intact fibula with medial condyle fracture may lead to varus deformity in the long run. If fibula is fractured in lateral condyle fracture it may lead to valgus deformity Open reduction and elevation of tibial plateau and bone grafting were first performed by dehelly in 1927.

Tibial plateau fractures were treated predominantly by traction or immobilization in splint – early 1950s. In a study by **Apley**[3]**,** traction of the affected limb and immobilisation for a short period followed by early motion had favourable outcome. He developed traction techniques successfully that allowed early mobilisation without compromising the fracture reduction. He published his studies in 1956 suggesting that non-operative treatment had satisfactory outcomes comparable to operative treatment.

In 1958, AO group developed open reduction and stable fixation techniques which permitted absolute stability of fixation and early motion without fear of displacement and subsequent malunion. New implants and instruments were developed which ensured attainment of the new goals of Open reduction and internal fixation.

Lasinger et al[4] in his study found out that coronal instability of more than 10 degrees was not favourable for non-operative treatment and results were based on long term followup study.

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Charnley advised open reduction and perfect articular congrugent reduction for intra articular fractures in the year 1961. But the techniques and implants available at the time made the goal unachievable. Unstable knee after closed reduction went in for future osteoarthritis and favourable results were obtained after open reduction and internal fixation of fractures by **Schatzker, Mcbrown, Bruce**[5] by the end of 1960s. Rasmussen described in his study emphasizing the correlation between Post-traumatic osteoarthosis and imperfect articular congruity and condylar widening. This lead to the concept of open articular reduction and internal fixation. Classification by schatzker et al remains central for classifying the fracture.

Robert D. Welch used tricalcium phosphate bone substitutes in the metaphyseal region to fill the void.

Lambotte showed that articular congruency, joint stabilisation, ensuring early range of motion, preventing mal-alignment were the key to favourable functional outcome. In 1980, Mitchell and Shepard in their study found out that Articular cartilage regeneration correlates with the perfect reduction and improper articular reduction lead to rapid cartilage degeneration and Osteoarthrosis.

In 1988, Kettlekamp and co-workers showed that restoring the mechanical axis alignment is essential to prevent post traumatic arthrosis. In 1989, Mast and co-workers developed methods for indirect reduction, antiglide plate fixation and composite fixation.

In 1997, **Lobenhoffer**[6] approached the tibial plateau fractures by a posteromedial skin incision with plane between pes-anserinus and medial head of gastrocnemicus.

In reference to article published by **Barie, David, O'Mara**[7]**,** 74 % of cases of bicondylar fracture had posteromedial fragment.

Honkonen, in 1995, showed that the radiological appearance does not seem to correlate with the functional outcome.

In 2003, Robert D. Welch, Hong Zhang, Dwight G. Bronson experimentally concluded that the void after elevation of the articular fragments can be augumented with calcium phosphate cement to serve as a suitable alternative to autologous bone grafting.

In 2009, Higgins Thomas studied the incidence and morphology of the posteromedial fragment in bicondylar tibial plateau fractures and concluded that Computed Tomography is essential to rule out posteromedial fracture fragment.

Luo et al[8] in 2010 published about the three column concept of proximal tibia and advocated column specific fixation in plateau fractures.

Operative treatment involves,

- Single column fixation- Canullated cancellous screw fixation/Lateral buttress plating with or without Bone grafting
- Bicondylar plating- Risk of wound dehiscence and infection to be considered
- Sequential staged treatment in the form of definitive internal fixation following a initial temporary external fixation and soft tissue procedures
- Ilizarov ring fixators
- Hybrid external fixators
- LISS

ANATOMY

ANATOMY

Knee joint is one of the largest joints in the body. Its formed by articulation between distal end of femur, proximal tibia and patella. Knee joint is composed of Tibiofemoral joint and patellofemoral joint. Patellofemoral joint is synovial joint with patella articulating with the asymmentric sellar surface of the femoral condyles. Tibiofemoral joint is a synovial hinge joint with movements mainly in one plane-extension and flexion. The articular surfaces are bathed in the synovial fluid produced from the synovial lining of joint. The joint surfaces are covered with hyaline cartilage and has evolved for bipedal life in humans. Joint is covered by capsule which in turn covers the synovial lining and also sends attachments to ligamentous structures.

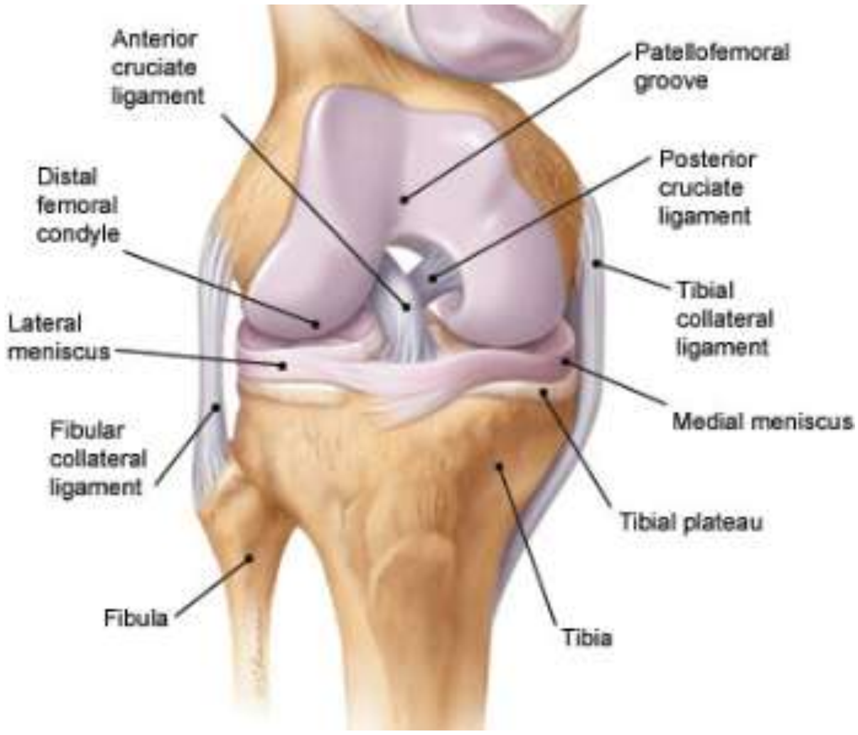


Figure 1 : Anatomy of Knee Joint

Knee joint is stabilized by following structures

- Fibrous capsule
- Tibial collateral ligament
- Fibular collateral ligament
- Posterior oblique ligament
- Arcuate popliteal ligament
- Oblique popliteal ligament
- Anterior cruciate ligament
- Posterior cruciate ligament
- Medial meniscus
- Lateral meniscus
- Transverse ligaments

Fibrous capsule

Articular capsule of knee joint is composed of two layers

- Inner synovial membrane
- Outer fibrous capsule

The outer fibrous layer, though thin, is strong and gives stability and connects various ligaments of knee. It extends superiorly beneath the tendon of quadriceps from the femur well proximally because of the presence of the suprapatellar synovial recess. Its chief strengthening bands are from fascia lata.

Tibial collateral ligament [9]

Also called the medial collateral ligament, it is composed of two layers mainly,

- Superficial medial collateral ligament
- Deep medial collateral ligament

Being the largest structure on the medial aspect of joint, the superficial layer has 2 tibial and a femoral attachment. The femoral attachment is from just posterior to medial epicondyle coursing towards tibia separated from it by inferior medial genicular vessels and nerves. In tibia, the proximal attachment is directly to anterior arc of semimembranosus tendon. Distal attachment is anterior to posteromedial crest of tibia. The posterior aspect of this ligament blends with the expansion of the semimembranosus.

Deep medial collateral ligament, which is a thickening of medial joint capsule, has the femoromeniscal and tibiomeniscal attachments. It is also known to be the mid-third medial capsular ligament.

Fibular collateral ligament

The lateral collateral ligament, round cord like structure, arises from the lateral epicondyle of femur. It has no capsular or meniscal attachment rendering it mobile when compared to its counterpart and making it less susceptible to injury. Its is inserted into the head of the fibula and is an important structure contributing stability to the posterolateral corner of the knee. Is covered by the tendon of biceps femoris and immediately beneath it is the inferior lateral genicular vessels.

Figure 2 : Posterior Anatomy of Knee Joint

Posterior oblique ligament [10]

Present in the medial aspect of the knee joint it has three arms- capsular, central and superficial arm. The central arm, being the thickest and largest portion, arises proximally just posterior to the superficial part of medial collateral ligament. It courses distally and attaches to the posteromedial joint capsule and posteromedial part of tibia. The capsular arm blends with the medial aspect of the oblique popliteal ligament and reinforces the meniscofemoral aspect of capsule in medial side.

Arcuate popliteal ligament

The Y shaped extracapsular ligament arises from the posterior aspect of the fibular head and divides into two arms in the form of Y and the medial arm blends with oblique popliteal ligament and lateral arm with the lateral head of gastrocnemicus attaching to lateral epicondyle of femur.

Oblique popliteal ligament [10]

Formed from the fasiculations of the semimembranosus it runs upwards and laterally towards the lateral condyle of femur. It forms the floor of popliteal muscle where popliteal artery traverses.

Anterior cruciate ligament

It arises from the medial wall of the lateral femoral condyle and gets inserted into the anterior part of the intercondylar region in tibia. It gives anteroposterior stability to knee joint along with the posterior cruciate ligament- one of the main stabilizers in sagittal plane. It can be differentiated into anteromedial and posterolateral fibre bundles. Oval shaped femoral attachment is much posterior on lateral femoral condyle thus placing the attachment posterior to the centre of rotation of the knee joint. The tibial attachment is 7-8 mm anterior to the origin of the posterior cruciate ligament. The anatomical footprint of Anterior cruciate ligament[11] reproduced during the arthroscopic repair. When placed more anteriorly it will lead to graft impingement after surgery.

Usually it is 24-37mm in length and is supplied by middle genicular vessels. The ligament is intracapsular but extrasynovial unlike meniscus.

Posterior cruciate ligament [12]

Being the largest one in knee joint it is the strongest ligament of knee with two functional units- anterolateral and posteromedial bundles. It is the primary stabilizer preventing posterior tibial translation during flexion of knee. It is believed the two bundles of ligament function reciprocally- Anterolateral bundle in flexion and Posteromedial bundle in extension. It orginates from the lateral wall of the medial femoral condyle, anterior when compared femoral anterior cruciate ligament origin. Ligaments of Humphrey and Wrisberg are anterior and posterior meniscofemoral ligaments named respectively in their relation to posterior cruciate ligament. Blood supply to posterior cruciate ligament is from the middle genicular vessels.

Menisci

They are semilunar, intracapsular, intrasynovial, fibrocartilaginous structures of the knee joint. Their structure deepens the articular surface and prepare the tibia that receive femoral condyles. Their functions[13] include

- Cushions and act as shock absorbers
- Increases the articular congruity
- Proprioception of knee joint

The peripheral border is vascularised and the free inner margin is less vascular so that tears in periphery heal satisfactorily when compared to one in white zone. The inner two thirds of menisci have collagen bundles arranged in radial fashion and outer one third has collagen bundles in circumferential fashion. This suggests differential biomechanical loading forces with periphery mainly resisting tensional forces and central zone resisting compression forces.

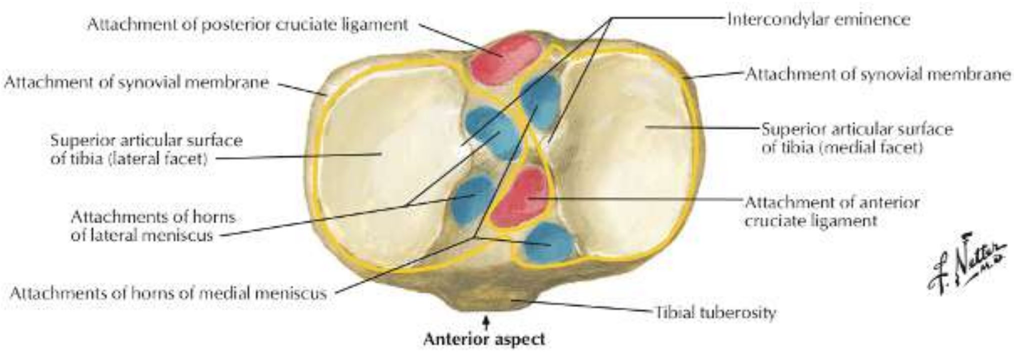


Figure 3 : Anatomy of Interior of Knee Joint

Medial meniscus [9]

Almost semicircular in shape it has an anterior horn which arises from the intercondylar region of tibia in front of Anterior cruciate ligament. Posterior fibres of the anterior horn is in continuity with the transverse ligament. The posterior horn is attached to the intercondylar region of tibia between posterior horn of lateral meniscus and posterior cruciate ligament. Coronary ligament also called the meniscotibial ligament attaches meniscus to the deep surface of medial collateral ligament and capsule making it less mobile when compared to its counterpart.

Lateral meniscus

It forms almost four-fifth of a circle and covers larger area when compared to medial meniscus. Anterior horn attachment in the intercondylar region of tibia is posterolateral to the anterior cruciate ligament. Posterior horn attachment in the intercondylar region of tibia is anterior to the posterior horn of medial meniscus. Posterolaterally it is grooved by the popliteus tendon and it seperates it from the lateral collateral ligament. It has attachments to the lateral aspect of the medial femoral condyle in the form of meniscofemoral ligaments. The meniscofemoral ligaments were named by their relation to the posterior cruciate ligament. Anterior one is called ligament of Humphrey[9] and the posterior one is called ligament of Wrisberg[9]. The meniscus is attached to the tibia by coronary ligament except in the region of popliteus muscle commonly referred to as the popliteal hiatus. The mobility of the lateral meniscus is mainly determined by the popliteus and meniscofemoral ligaments.

Transverse ligament

Also called the meniscomeniscal ligament, this ligament connects anterior horns of lateral and medial meniscus. It exerts a resistive effect on the anterior displacement of the horns of the meniscus when the knee is being extended.

ANATOMY OF THE MEDIAL PART OF KNEE

The ligaments of importance in the medial aspect[10] are the medial or tibial collateral ligament (superficial and deep layers) and posterior oblique ligament. Posterior oblique ligament as a separate entity is controversial since some authors consider it as oblique fibres of the superficial tibial collateral ligament.

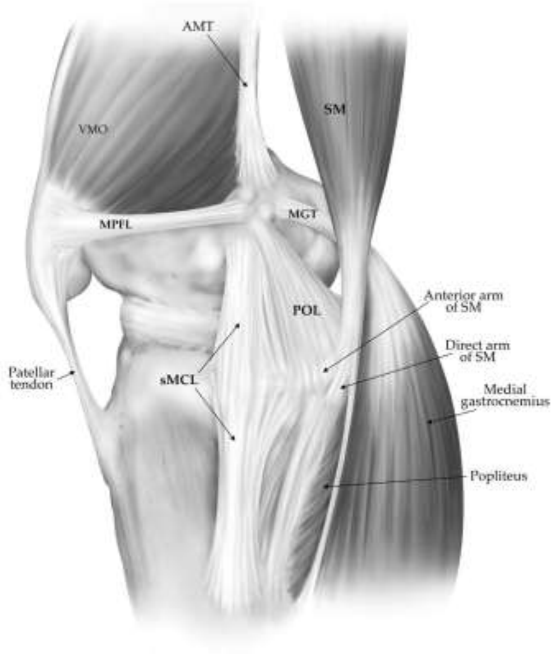


Figure 5: Anatomy of Medial Aspect Knee Joint

Fig. Abbreviations- AMT- Adductor Magnus tendon, MGT- Medial Gastrocnemicus tendon, POL- Posterior Oblique ligament, sMCL- Superficial medial collateral ligament, SM- semi-membranosus, VMO- Vastus Medialis Obliqus muscle

Medial Gastrocnemicus tendon

It attaches to the gastrocnemicus tubercle in the medial aspect of the medial femoral condyle. It has thick fascial attachments to adductor magnus tendon in lateral side and thin fascial attachments to posterior oblique ligament.

Pes Anserine tendons

Pesanserinus (meaning “goosefoot”) has attachments of the Sartorius, Gracilis, Semi-tendinosus in the anteromedial aspect of the proximal tibia. When retracted laterally it will be seen that the tendons attach in straight line along the lateral aspect of the anserine bursa with Sartorius on the top, followed by gracilis and semitendinosus. Sartorius has attachments to the superficial fascial layer and other two tendons have attachments to the deep surface of the facial layer.

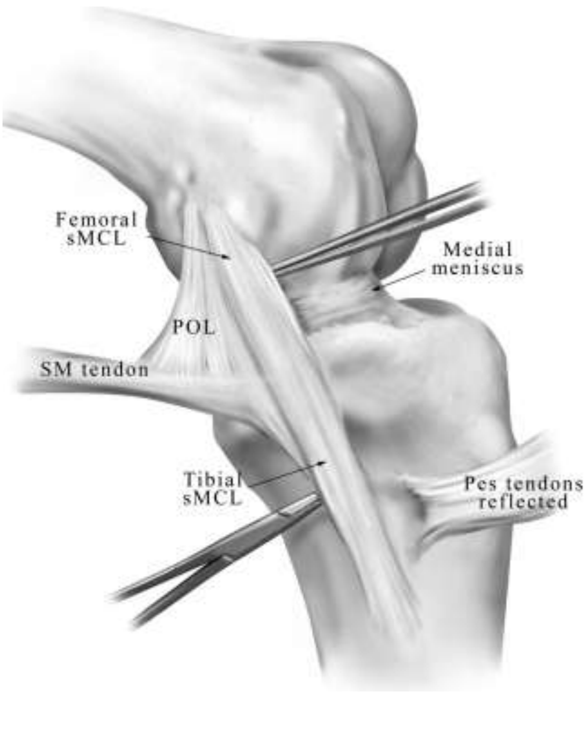


Figure 4 : Anatomy of Pes Anserine Tendon

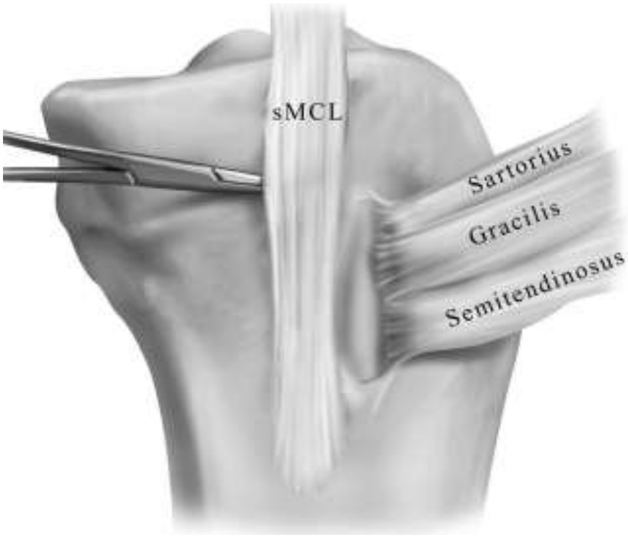


Figure 5 : Anatomy of Medial Collateral Ligament Attachment

Pes Anserine Bursa

Bursa overlying the pesanserinus tendons is seen at the medial aspect of the proximal tibia. Pes anserinus bursitis may lead to pain and swelling especially in athletes.

Semi-Membranosus tendon

Another important structure in the posteromedial aspect of the proximal tibia is the semimembranosus tendon attachment. The attachment has anterior and direct arm. Anterior arm attaches deep to superficial tibial collateral ligament attachment on tibia. Direct arm attaches distal to the joint line in the posteromedial aspect of the tibia. Semimembranosus bursa extends till the proximal attachment of the direct arm and extends further medially till the attachment of anterior arm.

Nerve supply

Innervation is from the

- Branches of the femoral nerve to muscles – vastus medialis, intemedius, lateralis
- Genicular branches of tibial and common peroneal nerves
- Posterior division of obturator nerve

Vascular supply

Blood supply is from rich anastomosis of 5 major arteries- superior medial, superior lateral, middle, inferior lateral, inferior medial genicular vessels.

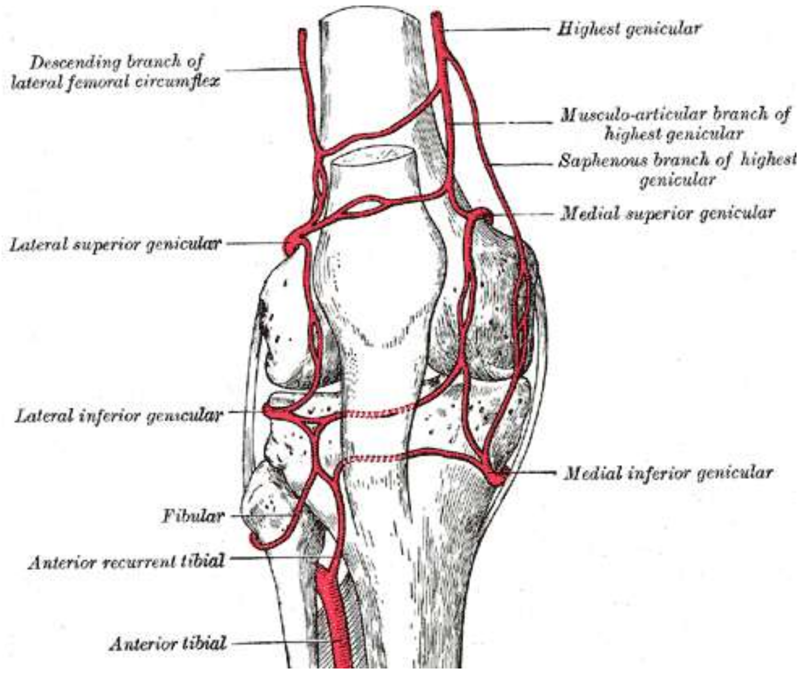


Figure 6 : Blood Supply of Knee Joint

Neurovascular structures at risk with these fractures are common peroneal nerve and popliteal artery. The course of common peroneal nerve[9] around the neck of the fibula makes it vulnerable to injury in case of displacement of fragments due to high energy trauma presenting usually as bicondylar fractures. The popliteal artery divides into the anterior tibial, posterior tibial, and peroneal arteries posteromedially in the proximal tibia. The vascular injuries usually occur as a result of knee dislocation but can also occur in cases of high velocity injuries presenting as fractures of the proximal tibia.

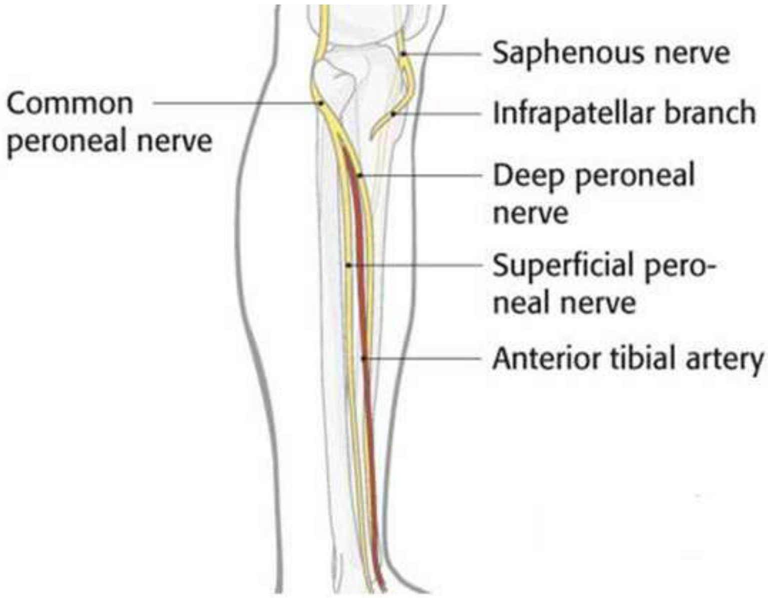


Figure 7 : Nerves Around Knee Joint

BIOMECHANICS OF THE KNEE JOINT

In a normal gait cycle, movement occurring at the knee joint have been found to be much more complex. than simple flexion and extension. Movements occurring are flexion and extension, abduction and adduction, and rotation around the long axis of the limb[14]. Knee flexion is a complex movement which occurs at varying levels of transverse axis such that there is 2mm posterior translation of axis on medial side when compared to 21mm translation on the lateral side. This has been observed by studies done using 3D CT and Dynamic Fluroscopy. This explains the external rotation of tibia on femur during extension of the knee joint. This is possible because of joint congruity and ligamentous constraints. This is called as the “screw home mechanism” in movements of knee joint.

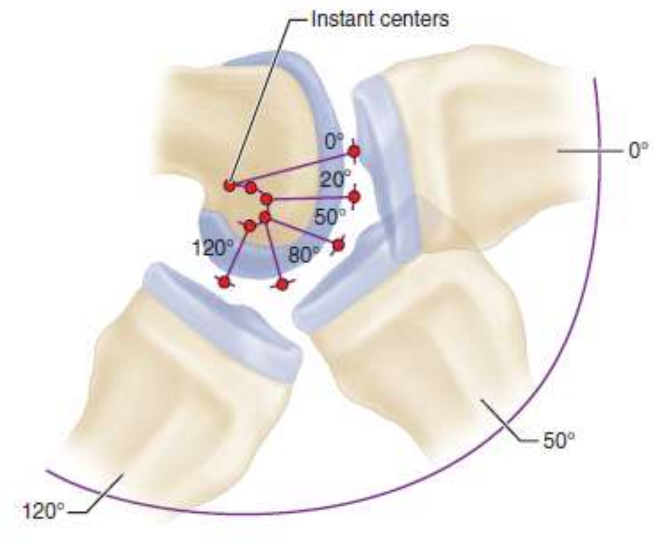


Figure 8 : Biomechanics of Knee Joint

The transverse axis of flexion and extension changes constantly and is represented as J-shaped Helical axis on the femoral condyles.

Neutral mechanical axis is drawn from the femoral head passing down the centre of the knee joint to the talar dome. This passes through or near the centre of knee joint and is in 3 degree valgus from the vertical axis of the body. Anatomical axis of the femur passing through its shaft is in 9 degree valgus to the vertical axis of the body. The anatomical axis of tibia is in 3 degree varus to the vertical axis of the body.

The varus alignment of the anatomical tibial axis contributes to the fact that lateral condyle is most commonly affected in split depression type of fractures of the proximal tibia. Moreover the direction of violence is also more common from the lateral to medial aspect of the knee leading to involvement of the lateral condyle in this type of fracture.

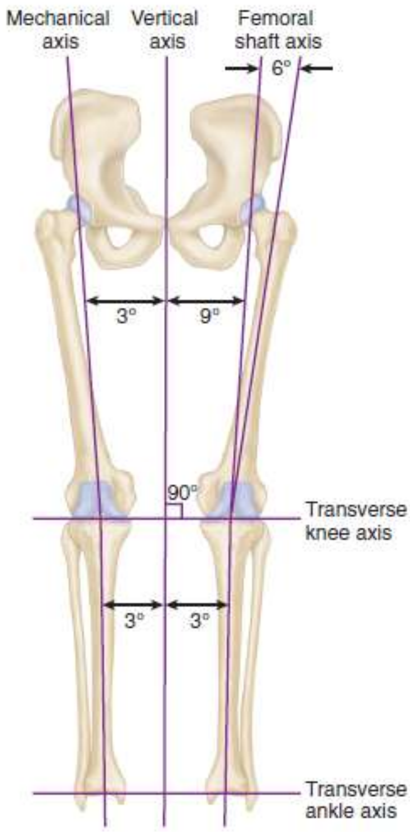


Figure 9 : Biomechanics of Knee Joint

TIBIAL PLATEAU FRACTURES

PROXIMAL TIBIAL PLATEAU FRACTURES

Being most common in younger age group it leads to loss of productive years in the society. Tibial plateau, like other intra articular fractures, must be addressed properly to prevent the morbidity associated with the condition. Tibial plateau fractures are a result of vertical thrust and bending forces leading to depression of articular surface. Joint instability resulting from the associated ligamentous injuries may increase the chance of developing post-traumatic arthritis. The term "complex knee trauma"[2] is used when there is significant damage to two or more of the following structures

- Soft tissue envelope
- Ligamentous structures
- Osseous structures of distal femur and proximal tibia

Complex knee trauma presents with 25 % chance of having a vascular injury and compartment syndrome at the time of presentation. Common peroneal nerve injury is twice as common as in pure fracture type. Sequential (staged) treatment (Definitive osteosynthesis following External fixation) is recommended in more complex fracture patterns.

CLASSIFICATION

FRACTURE CLASSIFICATION

Proximal tibial plateau fractures are classified originally by Hohl and later modified by Moore and Hohl[2]. Classification distinguishes between primary fracture patterns and associated dislocation patterns.

Five primary fracture patterns according to them,

Type 1, Minimally displaced;

Type 2, Local compression;

Type 3, Split compression;

Type 4, Total condyle;

Type 5, Bicondylar

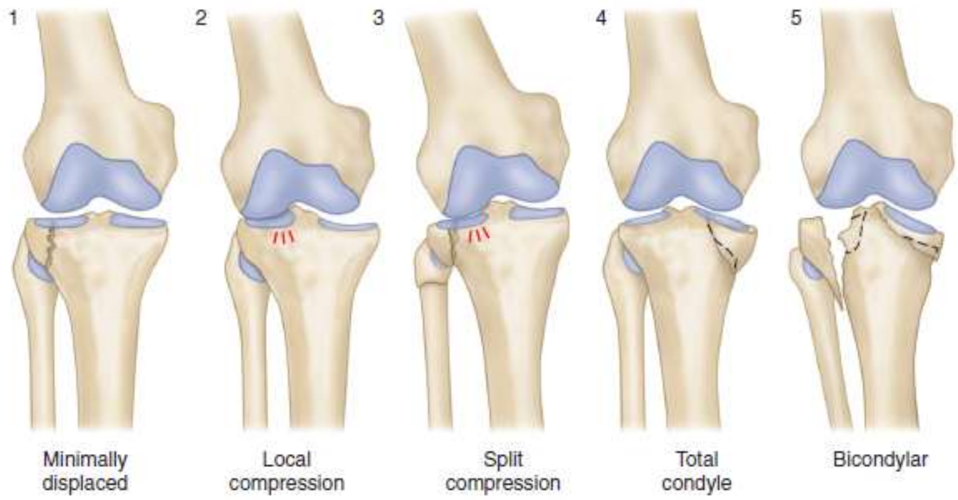


Figure 10.1 : Moore and Hohl Classification

Five fracture – dislocation patterns classified as

Type I- Coronal split fracture.

Type II- Entire condyle fracture

Type III- Rim avulsion fracture

Type IV- Rim compression fracture

Type V- Four-part fracture

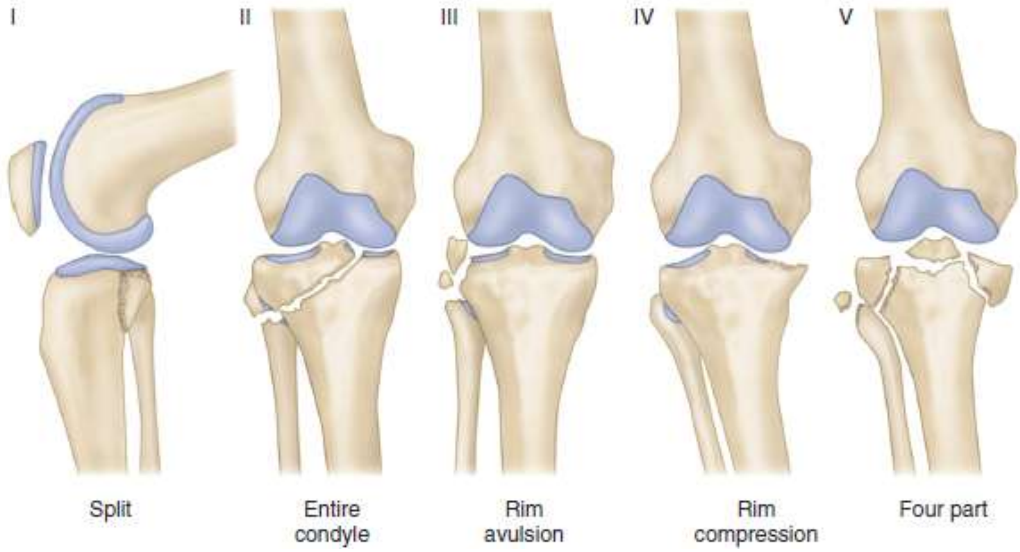


Figure 10.2 : Fracture Displacement Pattern

SCHATZKER FRACTURE CLASSIFICATION [2]

Type I- Pure cleavage- A typical wedge-shaped, uncomminuted fragment occurring commonly in young individuals.

Type II- Cleavage combined with depression- Lateral condyle is split off and articular surface is depressed. Reduction requires elevation of fragments with bone grafting of resultant hole in metaphysis. Lateral wedge is lagged on lateral cortex, protected with buttress plate.

Type III- Pure central depression- Lateral cortex remains intact but the articular surface is driven in. After elevation of depression and bone grafting, lateral cortex is best protected with buttress plate

Type IV- Fractures of medial condyle- Medial condyle is split and tibial spines most commonly involved.

Type V- Bicondylar fractures- Metaphysis and diaphysis retain continuity.

Bicolumnar plating preferably done.

Type VI- Plateau fracture with dissociation of metaphysis

and diaphysis

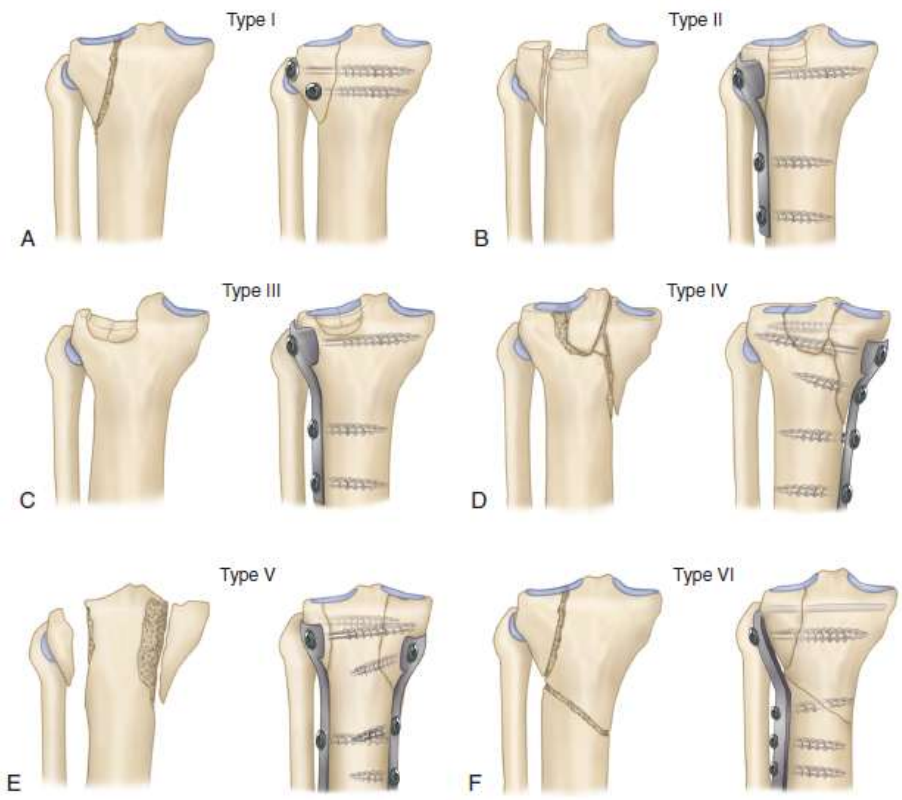


Figure 11 : Scatzker's Classification

AO/OTA CLASSIFICATION

Tibia is numbered 4 and proximal tibia as 1. Further divided into A,B,C based on articular surface involvement. There are further subdivided into three groups,

41A **Extra-articular**	A1	Avulsion
	A2	Metaphyseal simple
	A3	Metaphyseal multifragmentary
41B **Partial articular**	B1	Pure split
	B2	Pure depression
	B3	Split depression
41C **Complete intra-articular**	C1	Simple metaphyseal
	C2	Metaphyseal communition with simple articular fracture
	C3	Multifragmentary with communited articular surface

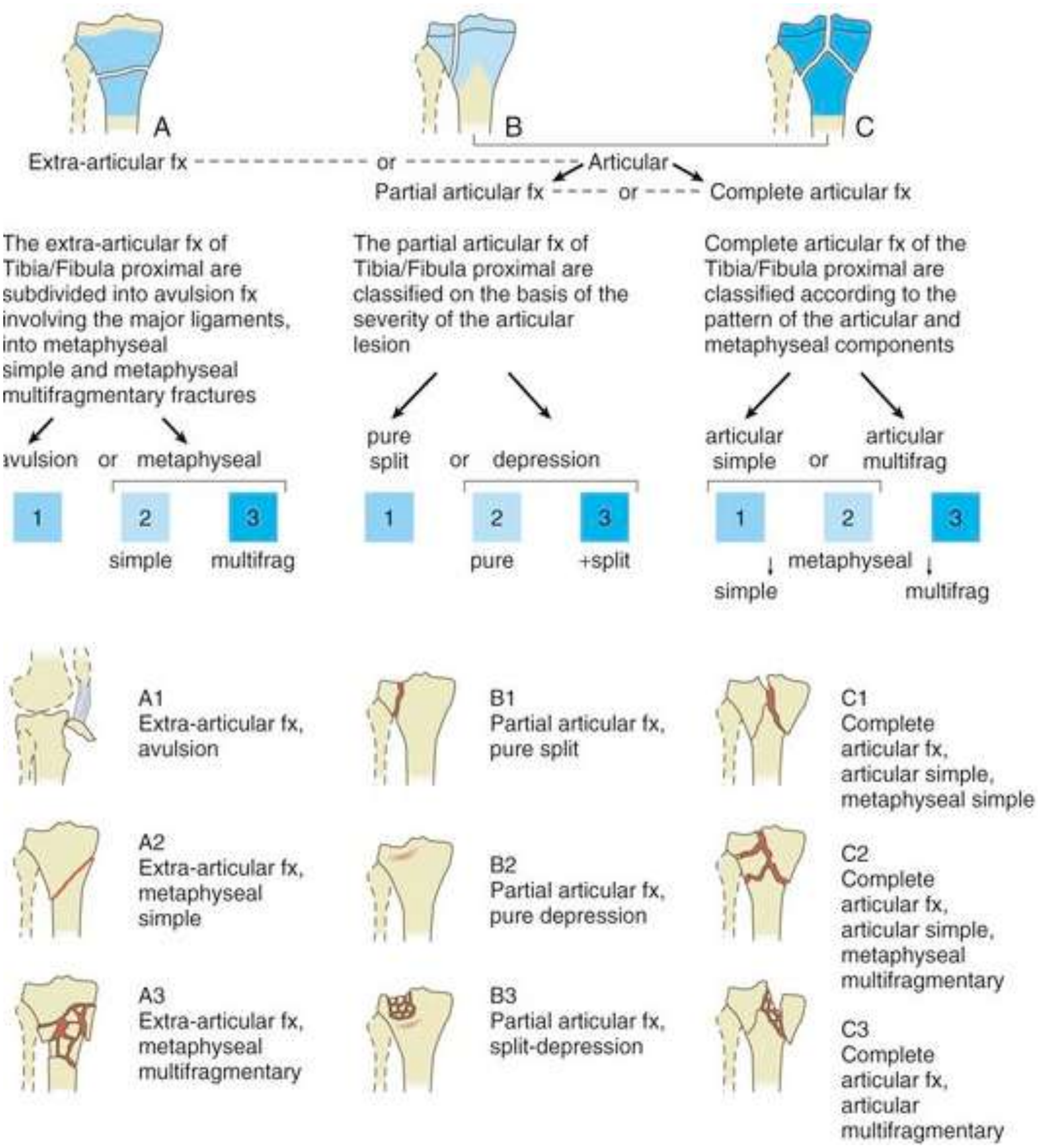


Figure 12 : AO Classification

THREE COLUMN CONCEPT

THREE COLUMN CONCEPT

Proximal tibial plateau is divided into three columns[15] and the division is mainly based on the imaginary lines in the transverse plane. A column fracture is described as an articular depression in addition to the fracture of the cortex. Zero column is articular depression without fracture extending to the cortex. The columns are divided as in the following picture,

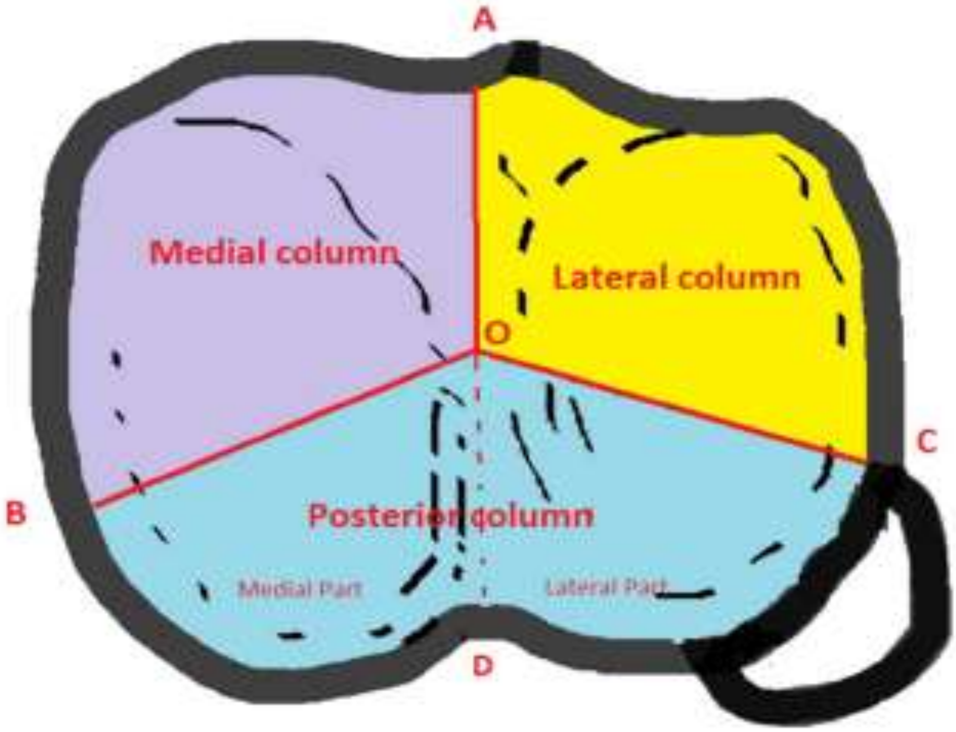


Figure 13 : Three Column Concept of Knee Joint

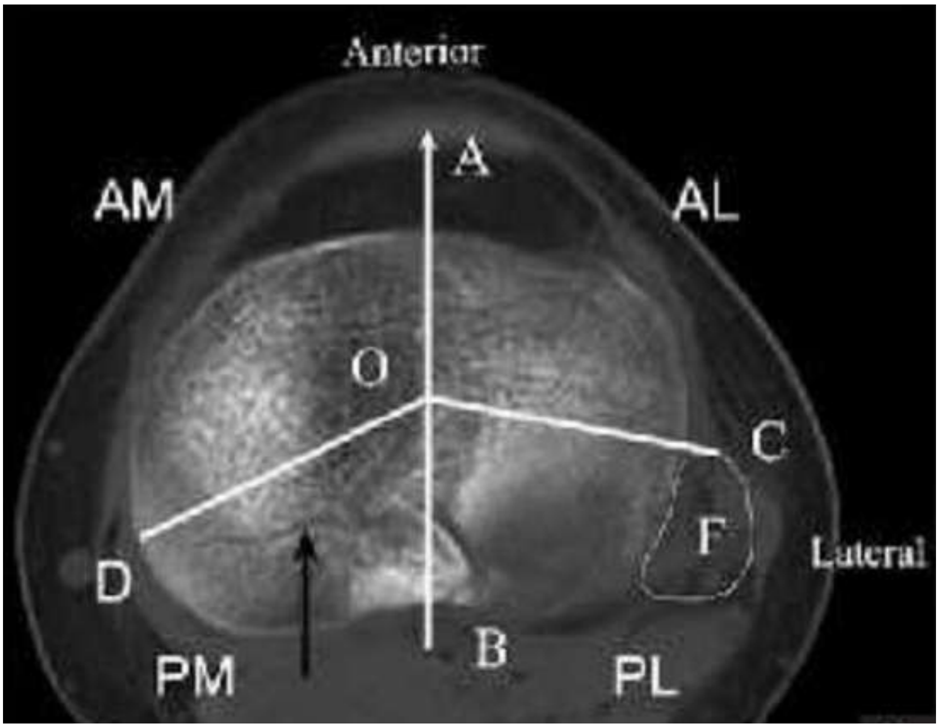
Point O- midpoint between the two tibial spines

Point A- on the Tibial tuberosity

Point B- on the Posteromedial ridge of tibia

Point C- on the anterior part of the fibular head

The axial section of the CT scan may show posteromedial fragment which is divided based on the three column concept



Significance of the posteromedial fragment

According to the three column concept, Complex bicondylar fractures follow a regular pattern which is not represented in the existing two dimensional fracture classification. Medial tibial plateau which takes up about 70% of the mechanical load should be reduced first. 3D CT scan mandatory in all cases of articular fractures of proximal tibia to identify the posteromedial fragment.

Associated ligamentous injuries

Tibial collateral ligament is the most common ligament to be injured associated with a proximal tibia fracture. The incidence percentage for ligament injuries[2] range from 10 to 33% following a tibial plateau fracture. A study by Colletti, Greenberg, and Terk showed medial collateral injuries in 55%, lateral meniscal injury in 45%, lateral collateral ligament injuries in 34%, anterior cruciate ligament injuries in 41%, posterior cruciate ligament injuries in 28%, and medial meniscal injury in 21%. The findings were based on MRI reports.

Surgeon must be aware of associated collateral ligament injuries and order for stress radiographs whenever necessary. Valgus and Varus stress tests can be done under anaesthesia with fluoroscopy to view opening out of the joint. If the stress view show opening of the joint space then collateral ligament injury is presumed. After fixation of the fragments, joint instability more than 10 degrees in the coronal plane may indicate the need for ligament repair. Meniscus is also commonly injured in the proximal tibial fractures. The incidence may raise after the advent of arthroscopy. Meniscal removal as a routine procedure for visualisation of the articular surface in case of fractures is not recommended.

MECHANISM OF INJURY

Tibial condylar. fractures usually caused by high velocity injuries and fall from height. Most common mechanism being. axial compression with valgus thrust, and indirect injury occur by shear forces[14]. Wedge shaped femoral condyle produce axial impaction. on the tibial plateau. The knee joint position and the direction and magnitude of the violence influence the amount of fracture fragment displacement.

Anatomically Knee is in 7 degree valgus and most commonly violence is directed lateral to medial from the outer aspect of the joint leading to involvement of the lateral condyle of tibial plateau. If single column is involved, it is most commonly the Lateral column. Age and bone quality also can affect. the fracture pattern. Elderly patients with osteoporosis sustain depression - type fractures with intact rim since the osteoporotic subchondral bone can’t resist axial loads. Split type fractures are common in young adults with. adequate bone quality. They were once described as Fender fractures since. the mechanism of injury is car-bumper vs pedestrian accidents. As described in recent literatures, the majority of tibial plateau fractures are the result of high-velocity. Road traffic accidents and fall from height.

Tibial plateau fractures occur as a result of

- Valgus or varus force on the knee joint
- Axial compressive force
- Combination of the above two forces

In a full extension, femoral condyle being wedge shaped is driven into the tibial plateau as a result of the deforming force leading to condylar fractures.

Pure split fractures are more common in younger patients, in whom the strong subchondral bone resist. The compressive force of the overlying femoral condyle but the shear component of the load produces a split. in the condyle with ligamentous disruption. In the elderly, osteopenic subchondral bone is no longer able to withstand compressive forces. As a consequence, split depression fractures become common. after the fifth decade. They have history of trivial trauma characterized by selffall and low energy injuries. In high-energy injuries, the deforming force explodes the plateau into numerous fracture fragments. They are more common in fall from height and high velocity road traffic accidents where axial load in an extended knee with or without the bending force results in involvement of both the condyles. Apart from fracture there may be associated soft tissue injuries

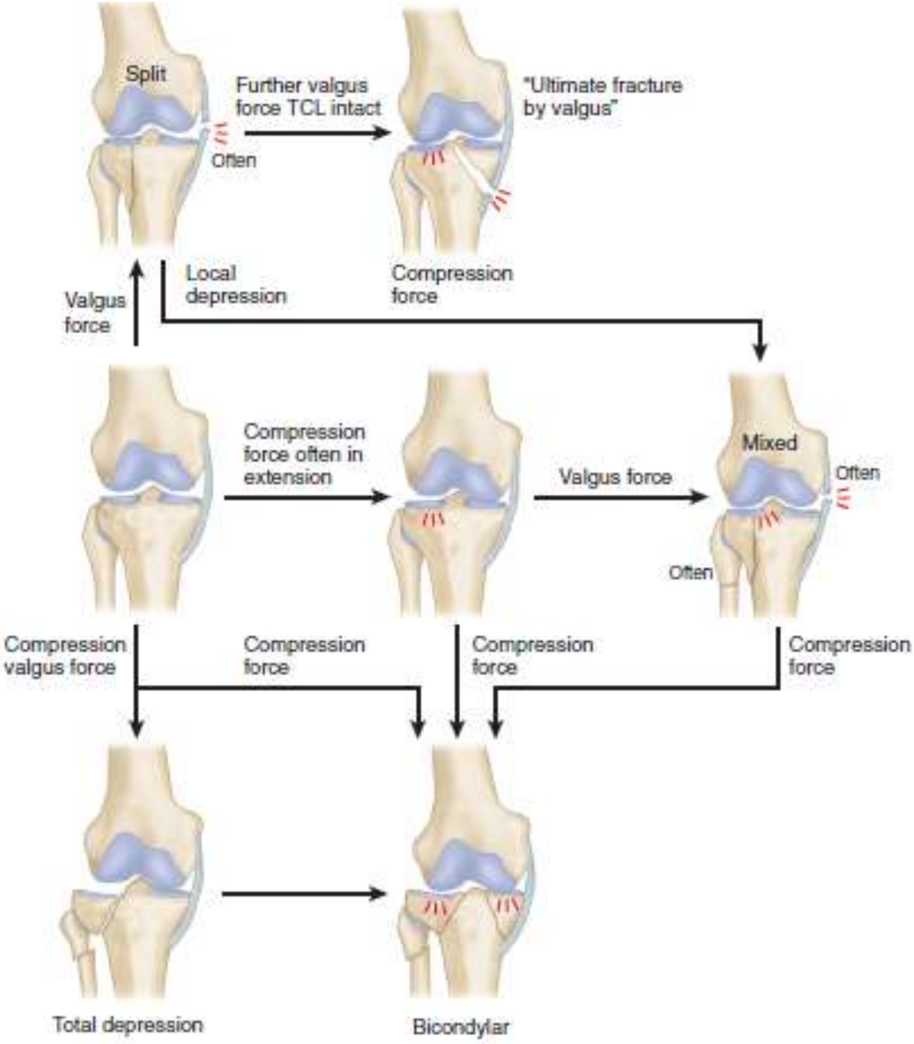


Figure 14 : Mechanism of Injury

MATERIALS AND METHODS

MATERIALS AND METHODS

The study was conducted at Government Royapettah Hospital Chennai and included 22 patients with Schatzker Type IV, Type V and Type VI proximal tibia fractures who fit the inclusion criteria. It was a prospective study with patients followed up for clinic-radiological outcome after obtaining a written informed consent from all patients.

INCLUSION CRITERIA:

- Age above 18 years(After physeal closure)
- Closed injury
- Fractures less than 2 weeks old
- Fractures involving the Medial column and Posterior column especially the posteromedial fragment regardless of the lateral column involvement.

EXCLUSION CRITERIA:

- Age <18 years or >60 years
- Fractures involving exclusively the Lateral column
- Fractures more than 14 days old
- Infection
- Medical Contraindications for surgery

INVESTIGATIONS

Patients were selected who fulfil the inclusion criteria and a complete detailed history was obtained and a clinical examination to identify associated soft tissue injuries, neurovascular complications and compartment syndrome. The pathology, suspected clinically, confirmed with X-rays and MRI scans.

Further basic investigations such as Complete hemogram, Complete blood count, Renal function tests, Chest X-ray PA view, ECG etc. were performed.

Standard trauma series radiographs include Antero-posterior view, Lateral view, Tunnel view, Sunrise or Merchant axial view. Mainly the anteroposterior and lateral views were taken which was supplemented with Computed Tomography and Magnetic Resonance Imaging.

Antero-posterior view- Patient is placed in supine position, with the knee in full extension and the leg in the neutral position, the beam is directed perpendicular to the knee with 5 deg to 7 deg of angulation.

Figure 15: X-ray of Knee Joint

Lateral view- With the patient supine on the affected side, knee is flexed 25 degrees and the central beam is directed perpendicular on the medial aspect of the joint with about 5° to 7° cephalad angulation

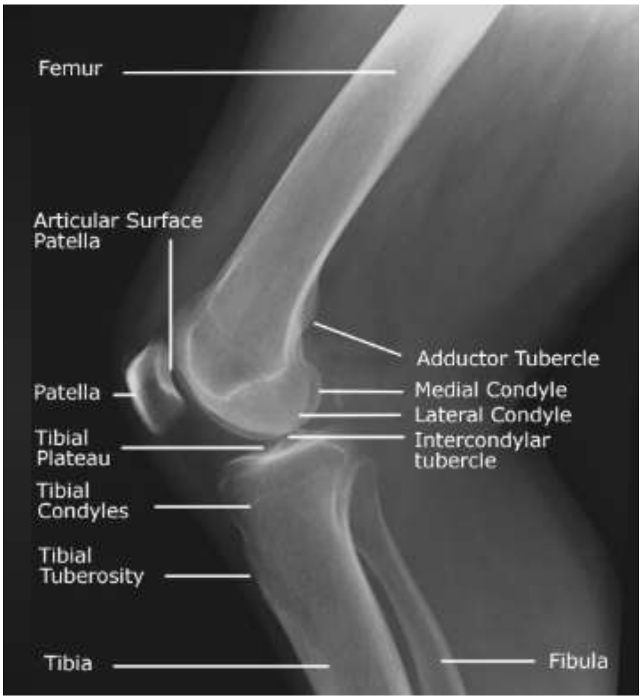


Figure 16 : Xray Lateral View of Knee Joint

Tunnel view - taken with patient prone and knee flexed to 45 degrees and beam directed 45 degrees from the vertical towards posterior aspect of knee. The posterior femoral condyles and the intercondylar notch are best visualized. If the anterior cruciate ligament is avulsed with bony fragment it is best visualized in this view.

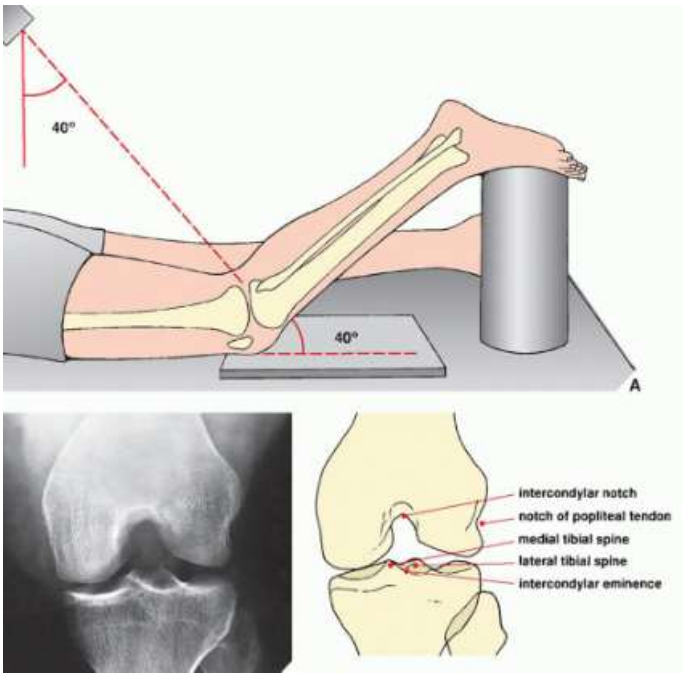


Figure 17 : Tunnel View of Knee Joint

The fractures were classified based on the Preoperative Computed Tomographic scans. MRI scans were also taken to visualize the ligamentous status. Fractures involving exclusively the Lateral column (lateral column in previous classifications- type I, type II, type III Schatzker) were excluded from the study. Fractures involving the Medial and Posterior column regardless of the lateral column involvement were included.

Associated ligament injury signs such as Segond's fracture[16] and avulsion fracture of the fibular head should not be missed. Calcification along the insertion of the medial collateral ligament may represent chronic injury to the medial collateral ligament and is commonly referred as Pellegrini-Stieda lesion[17].

COMPUTED TOMOGRAPHY

Computed Tomography reveals the tibial articular surface of any fracture line or depression with great detail. Its well established role in intra-articular fractures mandates investigation in tibial plateau fractures and it provides optimal visualization. of the plateau depression, defects, and split fragments. Conventional radiographs are deficient in cross sectional views of the tibial plateau and are they cannot delineate the posteromedial or posterolateral corners with accuracy. According to Luo et al CT scan is mandatory in all cases of tibial plateau fractures since they classify them based on column concept.

3D COMPUTED TOMOGRAPHY

They are useful for reconstruction images of the proximal tibial plateau in three planes. If fed to a software, they can predict the replacement of fragments with great accuracy.

MRI

Magnetic Resonance Imaging of the Knee joint is of great importance if the fractures are associated with significant soft tissue injuries. They can guide the treatment plan and need for ligament reconstruction in future. Tibial plateau, being the home to cruciate ligament and meniscal attachments, fractures involving them are frequently associated with ligament injuries. A valgus stress force along with axial compression may result in medial meniscal and anterior cruciate ligament injuries. Tibial spine avulsion fractures may be associated with cruciate ligament injuries and are best visualised by tunnel view. If clinically or radiographically ligament injury is suspected, MRI becomes necessary to guide treatment plan. Conservative treatment of tibial plateau fractures can be considered if they are undisplaced with no ligament injuries in MRI. However, the articular depression of more than 5-8mm as a consensus is considered cut-off for operative treatment. The MRI plays a major role in tibial plateau fractures[18] when the ligament injury is suspected clinically or radiologically by stress views.

TREATMENT PROTOCOL

TREATMENT PROTOCOL

Tibial plateau fracture management is a challenging task with dynamic role of many factors. The factors influencing the management of Tibial plateau fractures are

- Type of the fracture
- Degree of displacement of the fragments
- Depression of the articular surface
- Degree of comminution
- Age of the patient
- Associated ligamentous injuries
- Associated neurovascular injuries

Goals of treatment of tibial plateau fractures are

- Restoration of articular congruity
- Joint stability
- Joint alignment
- Functional motion

METHODS OF TREATMENT:

Various modalities of the treatment are

- Conservative treatment
- Surgical treatment

a) Percutaneous cancellous. screw fixation.

b) ORIF with lateral condyle. buttress plating

c) ORIF with medial condyle buttress plating

d) ORIF with bicondylar plating

e) ORIF with locking compression plate

f) Knee spanning external. fixator

g) Hybrid external fixator

SURGICAL TREATMENT:

INDICATIONS FOR SURGERY:

1. If articular depression is more than 10 mm, definitive surgery to elevate and restore the articular congruity, is indicated[2]
2. If the articular depression is 5. to 8 mm and the patient is younger with active lifestyle, Surgical reconstruction of the joint surface is justified**.**
3. The coronal plane misalignment is more than 5 degree

In an elderly patient with sedentary lifestyle with articular depression of 5 to 8 mm, nonoperative treatment usually is suitable.

PERCUTANEOUS CANCELLOUS SCREW FIXATION

The cases of type I Schatzker fractures, they can be treated with percutaneous cannulated cancellous screws after closed fracture reduction with ligamentotaxis. If there is difficulty in achieving closed reduction, meniscal interposition should be suspected. Arthroscopic evaluation of the meniscus and articular surface congruity may be needed. Open reduction and restoration of the articular congruity and fixation with cancellous screws is the next valid option. Usage of washers provides compression at the fracture site.

Figure 18 : Percutaneous Screw Fixation of Knee Joint

INTERNAL FIXATION WITH PLATE OSTEOSYNTHESIS

The plates being used in the treatment of plateau fractures usually function by buttressing the cortex against shear forces and providing rotational stability of the fragments. The also provide resistance against axial compression which is especially when used with raft screws and bone grafting to fill the metaphyseal void. Vulnerable soft tissue around the proximal tibia advocates use of thinner profile plates. Percutaneous plating, in which, the plate is slid subcutaneously without soft tissue stripping, has been advocated as a trend towards biological fixation. Bicondylar plating, eventhough prone for soft tissue complications, is preferred by many since it provides better functional outcome and stability. The likely complications of the soft tissue cover and subsequent infection must be weighed against the better stability and functional outcome of bicondylar plating. The use of anatomically pre-contoured low profile plates with minimal soft tissue devitalization through a separate incision is now recommended. Recent modifications of implant with features of anatomical precontouring, low profile and raft screws to prevent depression of fragment has shown promise to reduce the late complication of prominent hardware

POSTEROMEDIAL PLATING

Figure 19 : Posteromedial Plating System

EXTERNAL FIXATORS

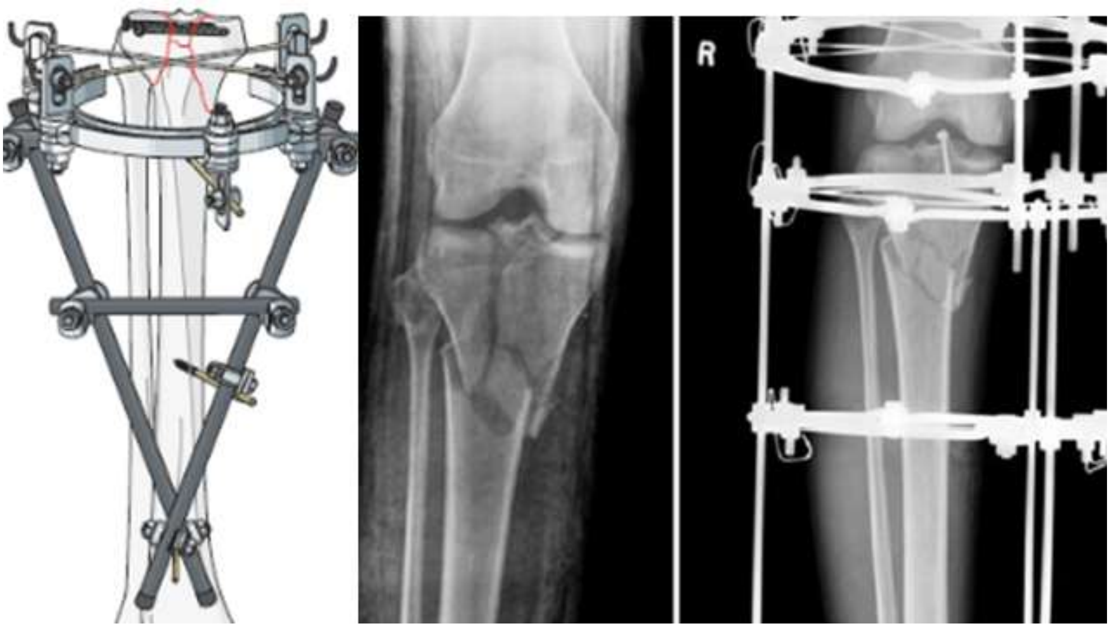


Figure 20 : External Fixation

External fixator[19] achieves interfragmentary compression by the use of olive wires. The 1.8 mm olive wire with an olive 4mm in size and eccentrically placed in wire when inserted across the fragments, achieves inter-fragmentary compression. After fracture reduction by ligamentotaxis, the olive wires are placed 10 mm to 14 mm below the joint surface. This technique avoids penetration of the joint and synovial recess posteriorly. This reduces the possibility of septic arthritis. There are cadaveric studies to suggest that there occurs a communication between the knee joint and tibiofibular joint. So if pin tract of the trans-fibular wire is infected there is always a potential chance of septic arthritis.

Advantages of the external fixator include minimal soft tissue dissection and ability to alter the frame stiffness to achieve compression between the fracture fragments.

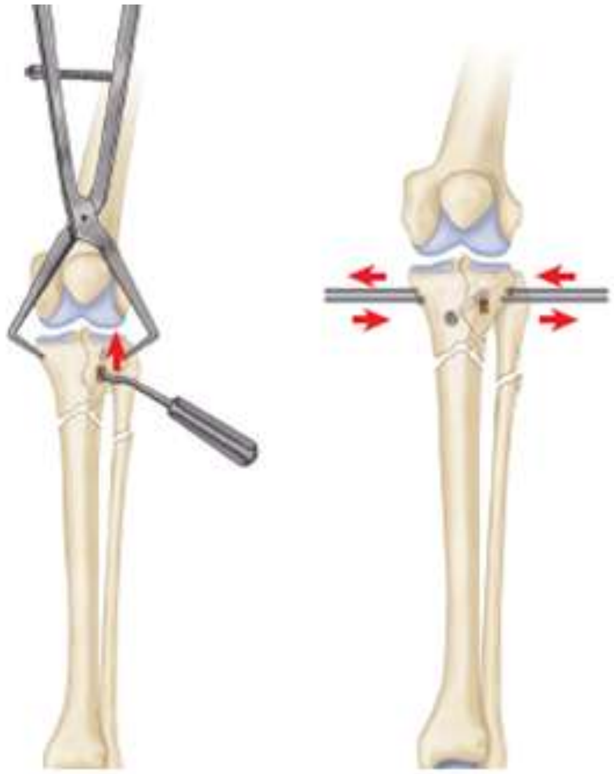


Figure 21 : Technique of Reduction in external fixators.

PROCEDURE

In all the cases, the medial condyle addressed first. Fractures involving the Medial condyle were treated using a specific Posteromedial Approach- Galla and Lobenhoffer approach.

POSTEROMEDIAL APPROACH TO PROXIMAL TIBIA

IMPLANTS AND INSTRUMENTS

Posteromedial Locking Plate of Proximal Tibia is 3.5 mm system locking plate[20]. Plate tapers from 3.4 mm to 1.9 mm thick. It has a low profile head which is 1.9 mm thick. It is available with 1, 2, 4, 6, 8, or 10 holes in the plate shaft. It has a Elongated Combi hole in the neck with allows for adjustment of plate placement intra-operatively. The screws in thehead portion of the plate have 5 degree divergence in the transverse plane and 3 degree divergence in sagittal plane. The inferior most screw of the head portion is 15 degree off the horizontal plane.

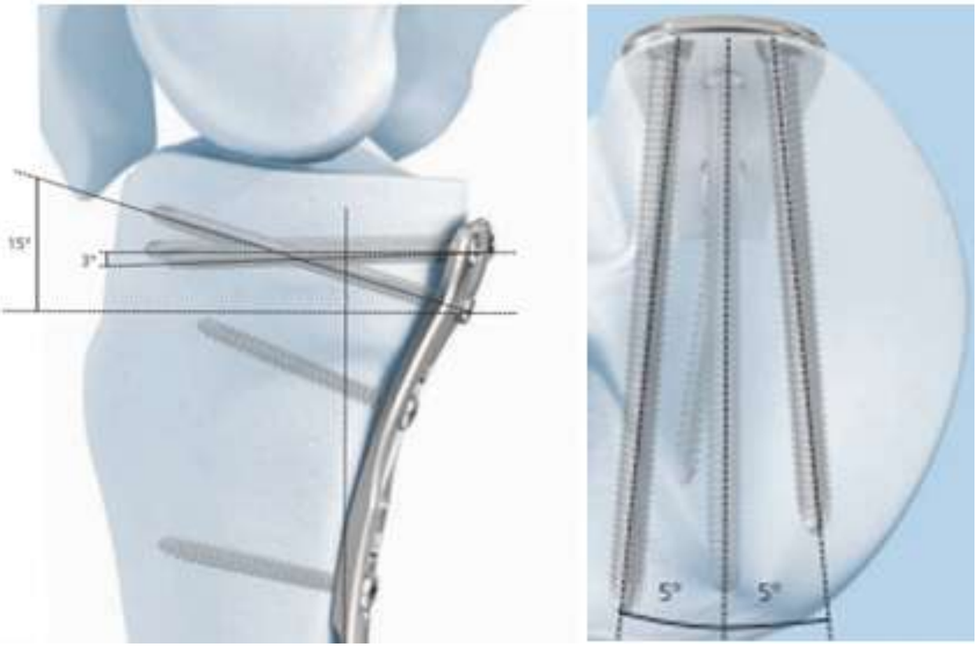


Figure 22 : Posteromedial screw entry

The plate is available in titanium and stainless steel. The implant used in our study is stainless steel. The following picture shows the implant used in our study,

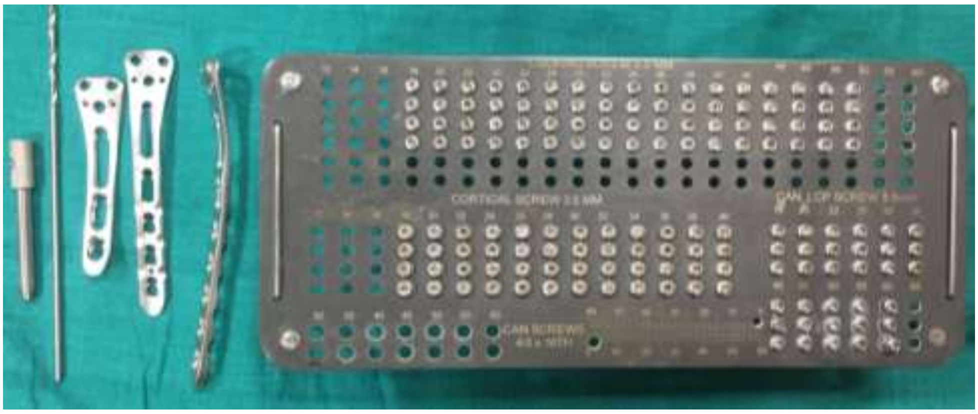


Figure 23 : Posteromedial Plate Implant Set

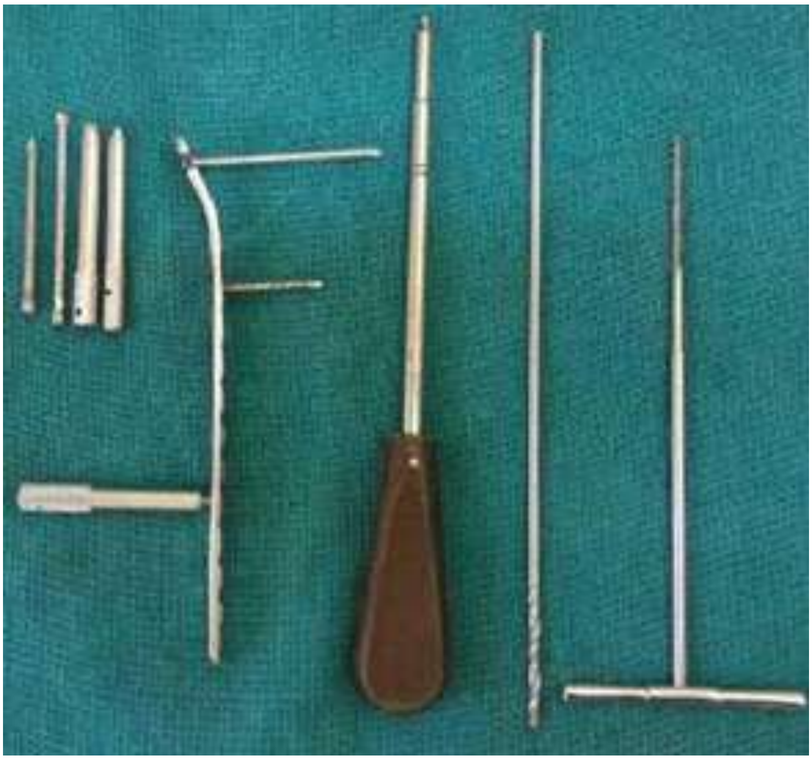


Figure 24 : Posteromedial Plate Implant Set

POSITION OF PATIENT

Patient is positioned with sandbag in the contralateral hip.

Figure 25 : Position of the Patient

INCISION

The incision follows the posteromedial border of proximal tibia after exposing the posteromedial aspect of the affected knee by postioning the patient with contralateral hip sandbag. The plane is between the Gastronemicus and Pes anserinus[21]. There is no true internervous plane.

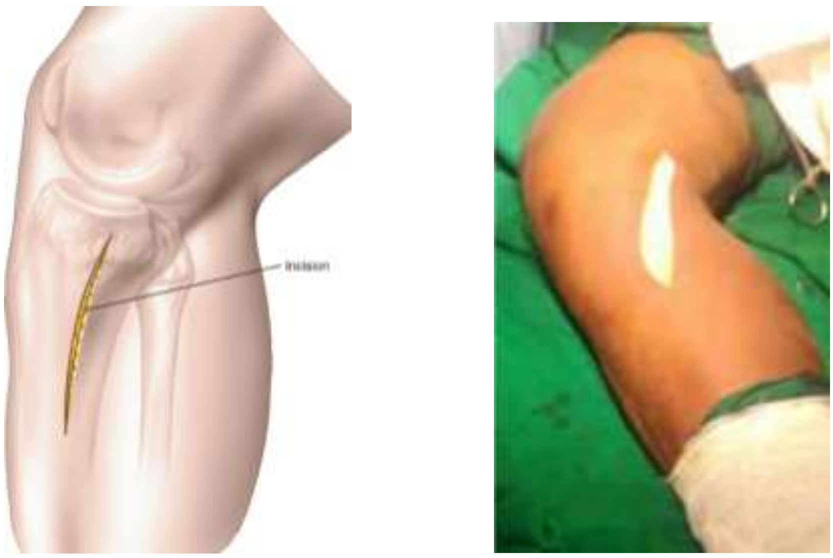
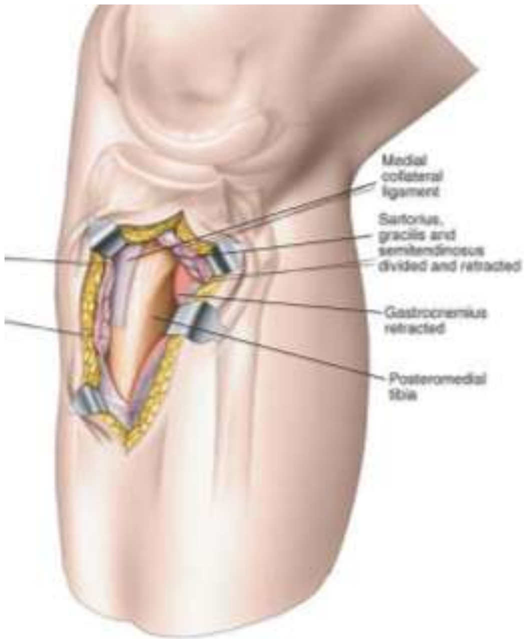


Figure : 26 Incision along posteromedial aspect of proximal tibia



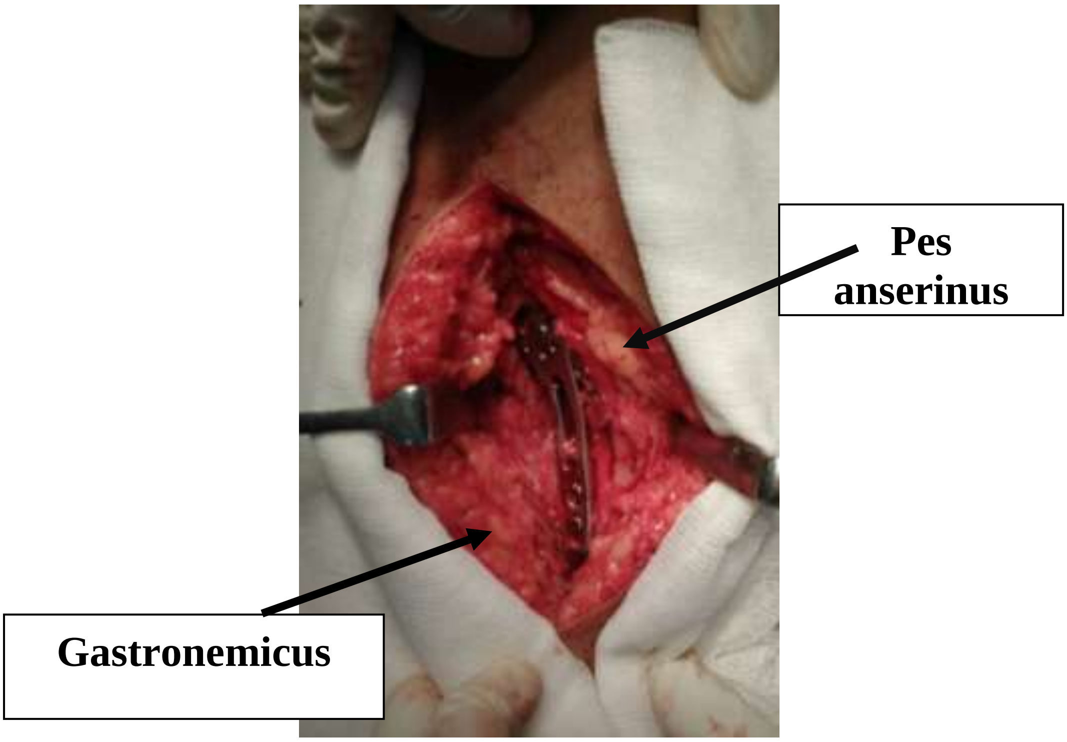


Figure 27 : Intraop picture of posteromedial plate being placed

STEPS IN PLATE OSTEOSYNTHESIS

Step 1- Reduction of fragments and placement of the plate

Step 2- Placement of the 3.5 cortical screw in the neck of the plate in the elongated combi-hole. The elongated hole allows for adjustment of the plate position.

Step 3- Placement of 3.5 self-tapping locking screws in the shaft of the plate. Combi-hole allows for placement of cortical screws also if plate to bone compression is desired. Before application of the locking screws, the fracture must be reduced since further reduction thereafter is not possible.

Step 4- Placement of 1.5 K-wire in the holes of head portion of the plate to check under fluoroscopy for joint penetration and to determine the length

Step 5- Insertion of locking screws in the head portion of the plate

ANTEROLATERAL APPROACH TO TIBIA

The lateral condyle if involved is addressed by a separate incision by anterolateral approach to proximal tibia.

POSITION OF PATIENT

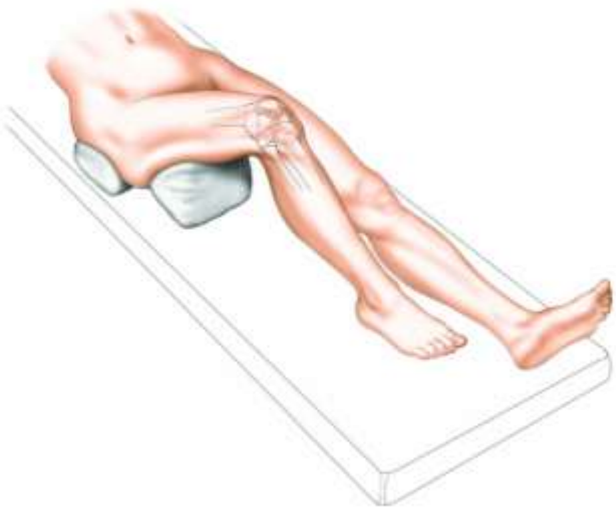


Figure 28 – Position of the Patient

Supine with sandbag under ipsilateral hip to compensate external rotation of tibia and knee flexed with bolster to 60 degrees

INCISION

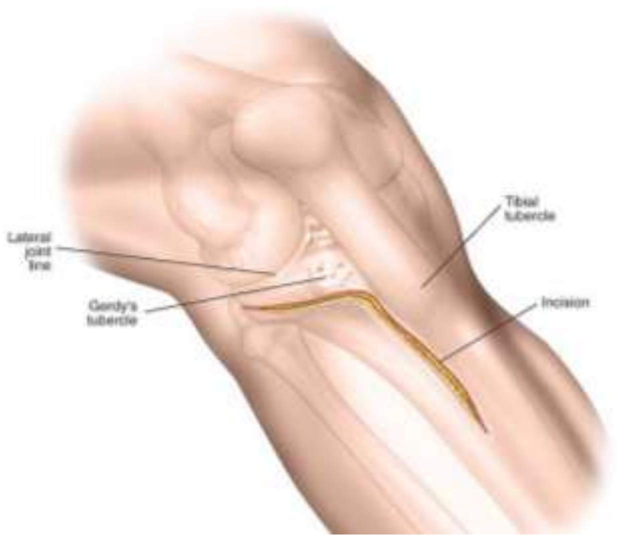


Figure 29 – Incision

S-shaped incision is made starting 3 to 5 cm proximal to the joint line and just lateral to patella tendon border. Incision is curved anteriorly over Gerdy's tubercle. Distal extension of incision depends on implant to be used and is 1cm lateral to anterior border of tibia.

PLANE OF DISSECTION

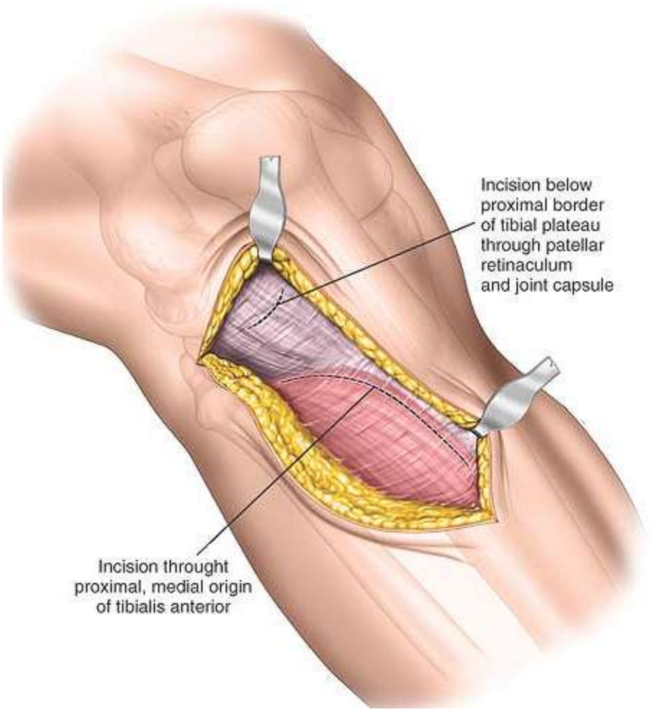


Figure 30 – Plane of Dissection

Superomedial border of Tibialis anterior is detached from proximal tibia with plane between muscle and periosteum. Tibial plateau can be visualized submeniscally.

POST OPERATIVE PROTOCOL

After the surgery,removable knee immobilizer such as knee brace is used. In first post-operative day, physical therapy in the form of quadriceps exercises and gentle active-assisted exercises were started. Drain was removed in the second post-operative day. Any soft tissue devitalisation or fractures of the tibial tubercle if associated the mobilization was a little delayed. Walking with the help of walker began, but patient was advised non-weight bearing. for 10 to 12 weeks till the radiological and clinical signs of union. The patients were regularly followed up at one month, three months and six months and results were drawn using Lysholm knee score[22].

OBSERVATIONS AND RESULTS

OBSERVATION AND RESULTS

Analysis of the cases were done as per the following criteria

- Distribution of Age
- Distribution of Sex
- Based on Classification of fractures
- Side of Injury
- Mode of injury
- Time interval between injury and intervention
- Time to Union in various groups
- Associated injuries
- Intra operative blood loss
- Lysholm knee score according to age
- Lysholm knee score according to type of fracture
- Lysholm knee score according to sex
- Complications

DISTRIBUTION OF AGE

The age group varied from 23 to 62 years of age. The Mean age of cases was 36 years of age. According to the literatures, Proximal Tibial Plateau fractures have a Bimodal age distribution. Young age is associated with high velocity trauma and old age is associated with osteoporosis.

Age group	No. of cases	Percentage
20- 30 years	7	35%
30-40 years	5	25%
40-50 years	6	30%
50-60years	2	10%

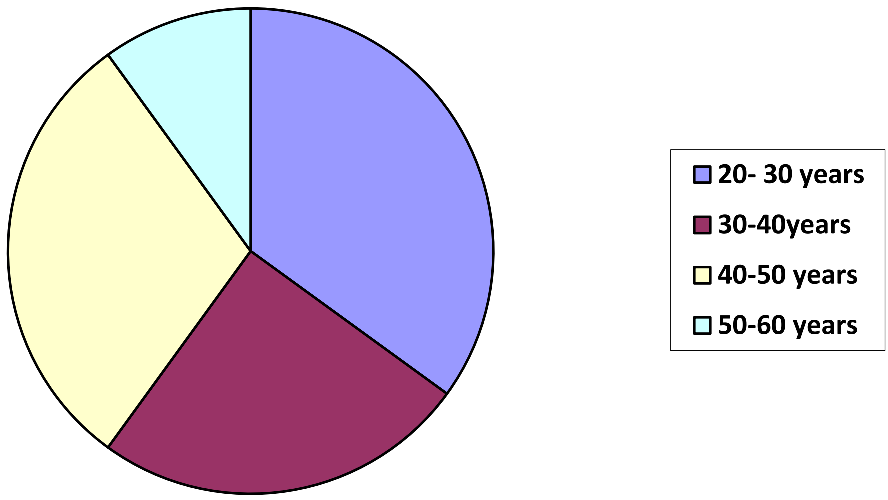


Figure 31 – Distribution of Age

DISTRIBUTION OF SEX

The study includes 16 males and 4 females. As per literature, Proximal Tibial Plateau fractures are more common in male.

Sex	No. of cases	Percentage
Male	16	80%
Female	4	20%

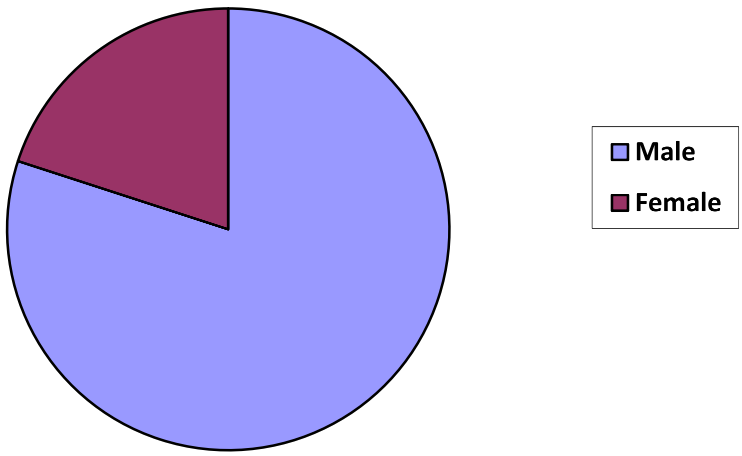


Figure 32 – Distribution of Sex

BASED ON CLASSIFICATION OF FRACTURES

The study includes type IV, V and VI Schatzker fractures of Proximal Tibia. Type IV predominates the study with 9 cases followed by type V and type VI which have 7 and 4 cases respectively.

Schatzker Type	No. of cases	Percentage
Type IV	9	45%
Type V	7	35%
Type VI	4	20%

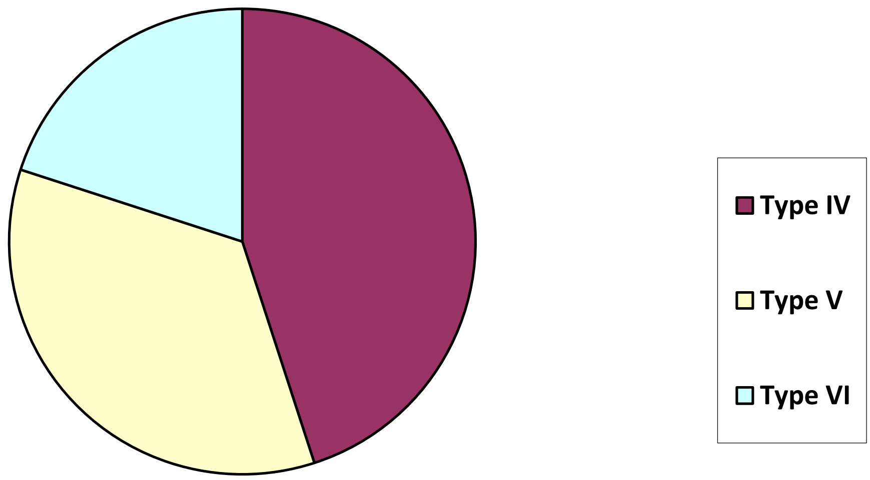


Figure 33 – Distribution of Cases Based on Fracture Type

SIDE OF INJURY

The study includes 13 right sided knee and 7 left sided knee

Side	No. of cases	Percentage
Right	13	65%
Left	7	35%

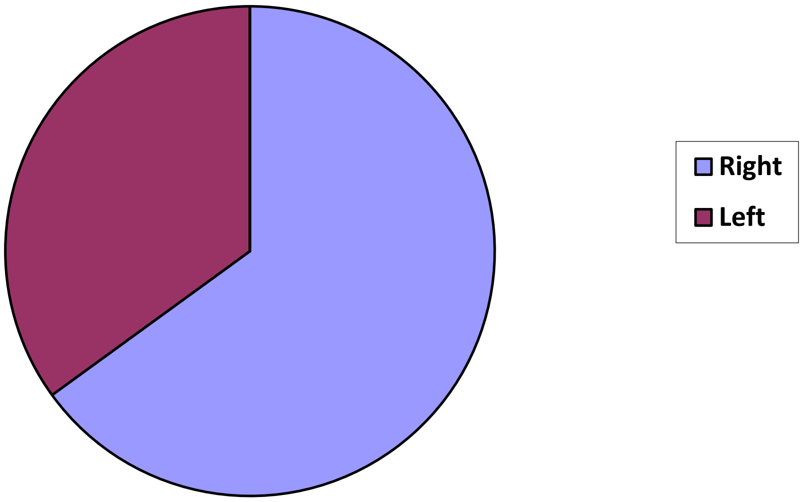


Figure 34 – Distribution of Sex

MODE OF INJURY

Road Traffic Accident (RTA) accounts for majority of cases followed by Self fall.

Mode of injury	No. of cases	Percentage
RTA	12	60%
Selffall	6	30%
Fall from height	2	10%

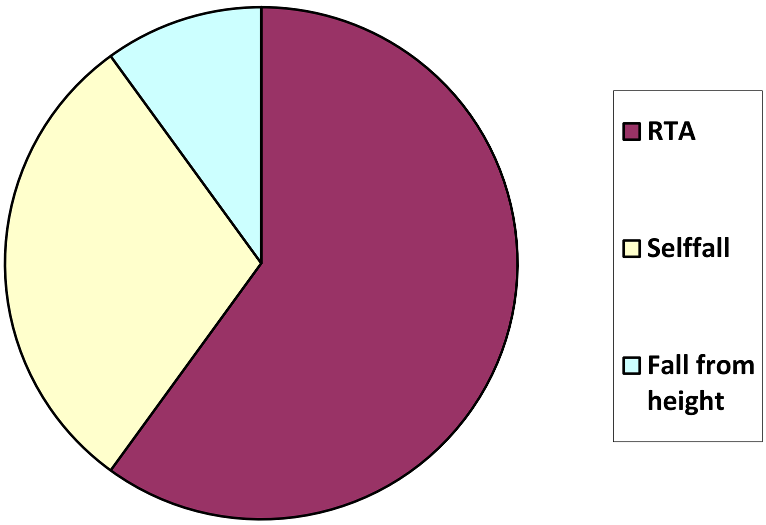


Figure 35 – Distribution of Mode of Injury

TIME INTERVAL BETWEEN INJURY AND INTERVENTION

The time interval between initial injury and surgery is mainly decided by the soft tissue status of the limb. If the case had unfavourable skin conditions then surgery is deferred till the soft tissue edema subsides.

Injury to surgery time interval	No. of cases	Percentage
<2days	12	60%
2-5days	2	10%
5-14days	6	30%

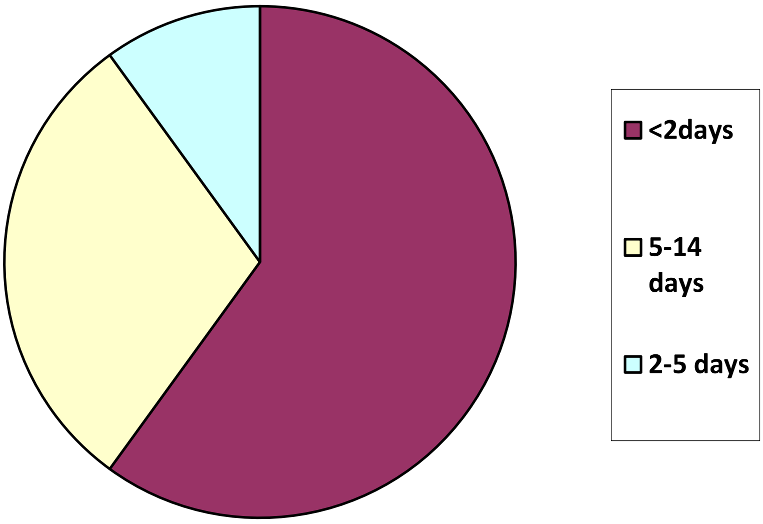
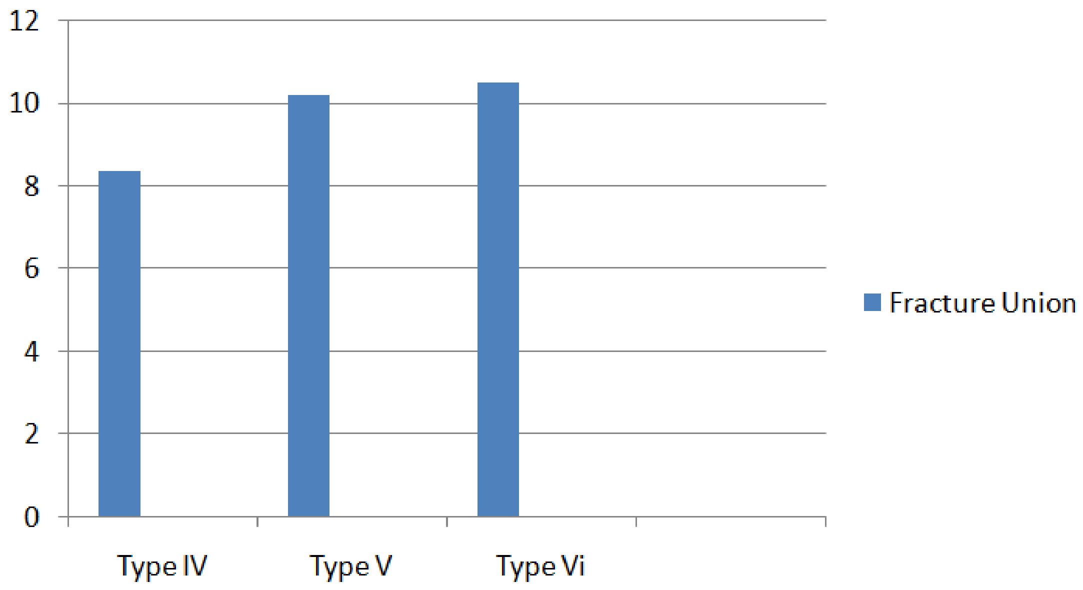


Figure 36 – Distribution of Time Interval

TIME TO UNION

ACCORDING TO FRACTURE TYPE

Mean time for fracture union was 9.7 weeks. The type of fracture greatly influenced the time to union with type VI having a mean union time of 10.5 weeks. Type V and IV had union at 10.2 and 8.4 weeks respectively.



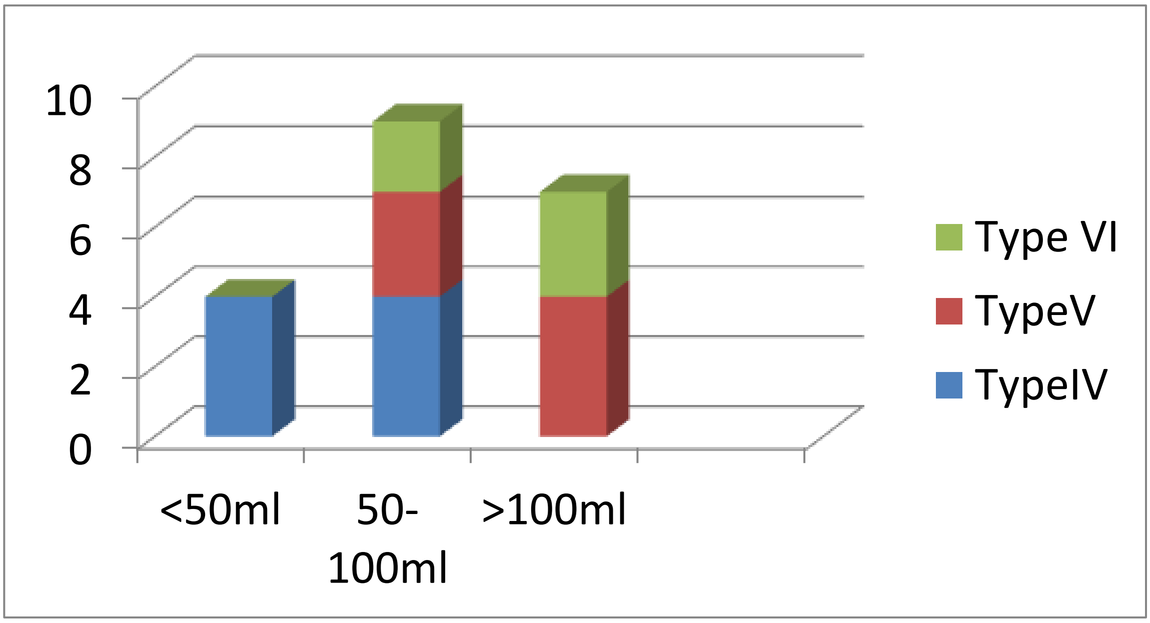
ASSOCIATED INJURIES

One case had associated distal radius fracture. Another case had associated distal humerus fracture. In both the cases, Tibial plateau was addressed first and then upper limb in subsequent sitting.

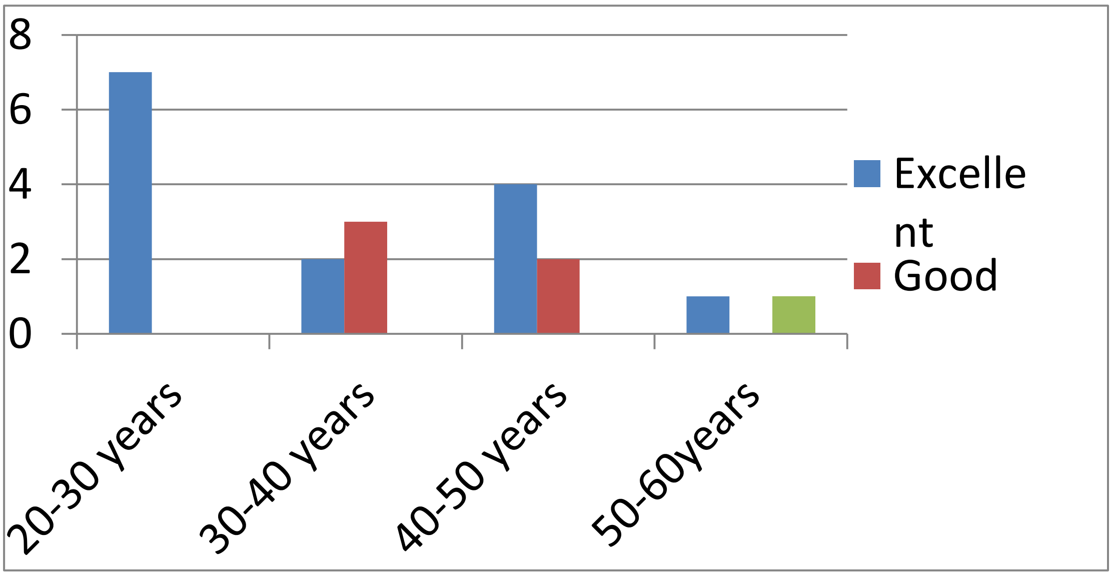
INTRA-OPERATIVE BLOOD LOSS

In our study, the blood loss seemed to correlate with the type of fracture and type VI having more blood loss since they associated with high velocity injuries and bicondylar fixation. The blood loss ranges from 30 ml to 150ml with the mean of 70.5 ml.

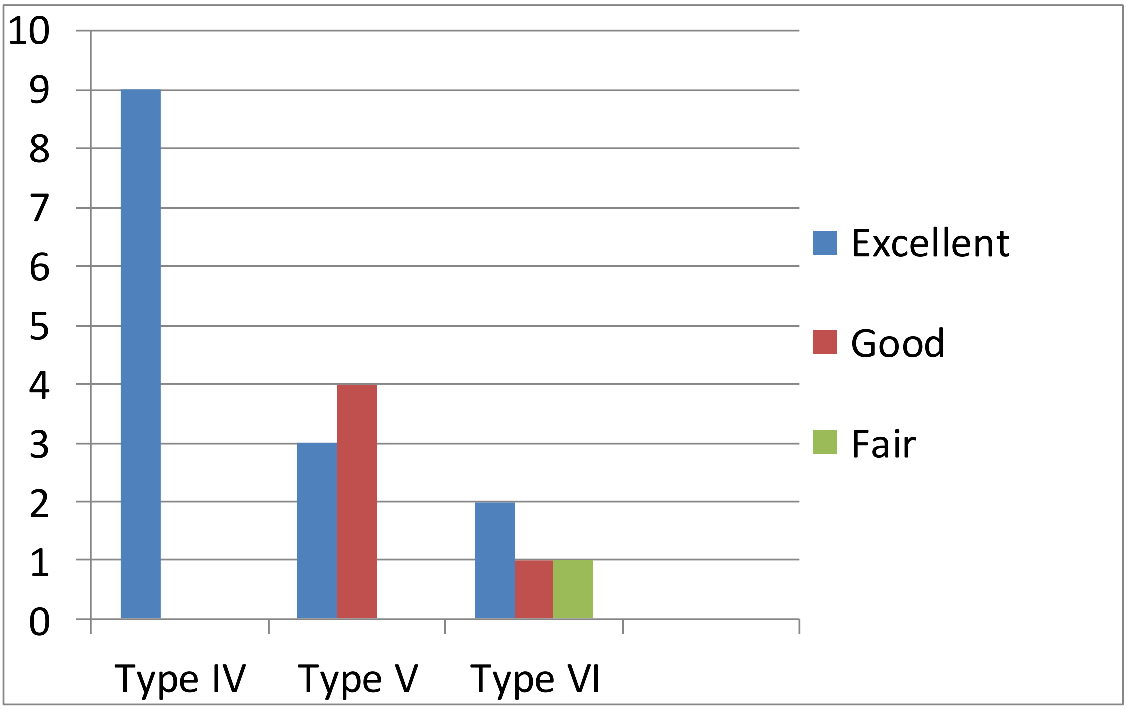
Blood loss	No. of cases	Percentage
<50ml	4	20%
50 to 100ml	8	40%
>100ml	8	40%



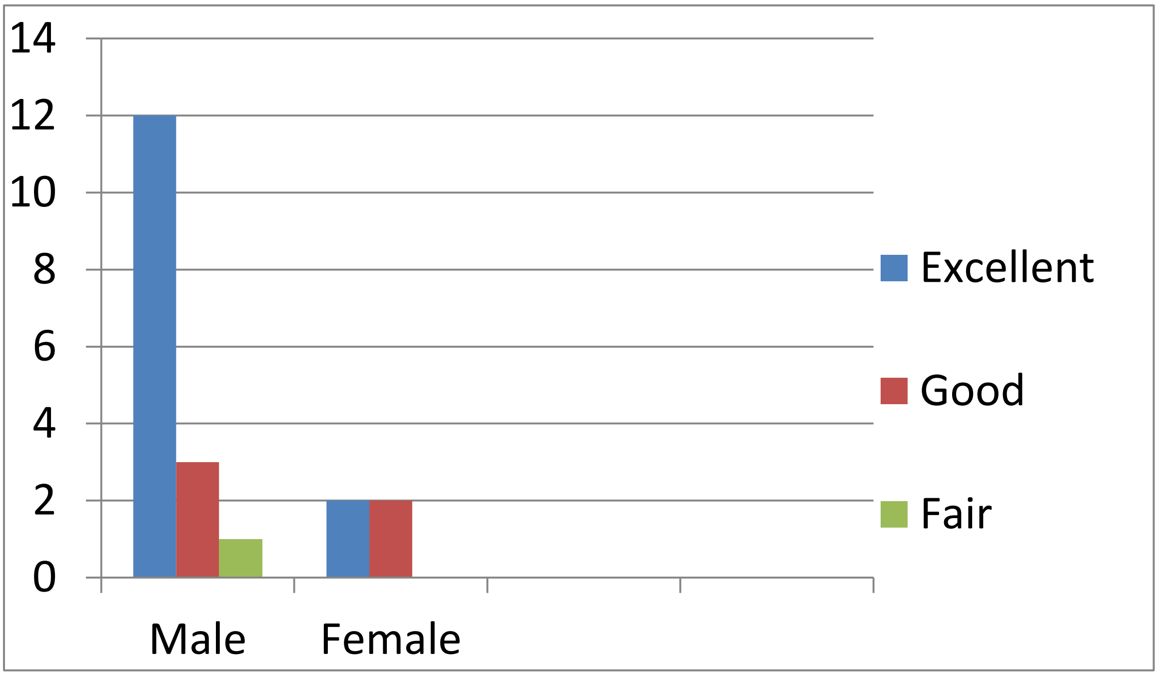
LYSHOLM KNEE SCORE ACCORDING TO AGE



LYSHOLM KNEE SCORE ACCORDING TO FRACTURE TYPE



LYSHOLM KNEE SCORE ACCORDING TO SEX



COMPLICATIONS

COMPLICATIONS

EARLY COMPLICATIONS

Tibial plateau fractures are considered soft tissue injuries with fractures inside. The skin condition may predispose to operative delay and post operative infection. Most severe complication following surgery for tibial plateau is infection which ranges from 3% to 38% depending on the preoperative soft tissue status, mode of injury and surgical technique being applied. Deep infections may range from 2% to 9.5% and pin tract infections following external fixator application may be upto 33%. The concern of the surgeon should be towards development of septic arthritis if there is communication between the pin tract infection and knee joint capsule[23]. Soft tissue devitalisation may result from various factors including bicolumnar fixation with extensive osseous devitalization and poor soft tissue closure techniques.

Thromboembolic complications[24] may occur after operative treatment of tibial plateau fractures. Deep vein thrombosis ranges from 5% to 10% of the cases in some studies and pulmonary embolus occurs in 1% to 2% of patients. Prophylaxis against Deep Vein Thrombosis includes administration of low-molecular-weight heparin or Coumadin and usage of compression stockings. If suspected, aggressive treatment of pulmonary embolus is essential.

LATE COMPLICATIONS

Late complications include chronic knee pain related to hardware, post-traumatic arthritis and valgus or varus collapse leading to Malunion. The most common late complication following surgery is symptomatic hardware [26] which ranges from 10% to 54%. Usually hardware can be removed 1 year from the date of surgery if clinic-radiological union has occured. Loss of fracture reduction may be result of inadequate buttressing of lateral cortex which may be fractured in association to medial condyle. Elevation of articular surface with bone graft or bone substitutes may prevent post-operative collapse and malunion. In our study, two patients required articular elevation and bone grafting. Initial chondral damage or residual joint incongruency following surgery may lead to post-traumatic arthrosis[35]. Preservation of meniscus and ability to load bear weight in the lateral column may lead to adequate function despite destitute radiological outcome[27]. Uncommon complications are popliteal artery lacerations, osteonecrosis, and non-union.

In our study, two cases had superficial infection and another case had knee stiffness. Both the cases with superficial infection subsided without any consequence with intravenous antibiotics. Another case of Knee stiffness was the result of inadequate mobilisation of the patient due to poor follow up. Majority of the cases did not encounter any complication.

Complication	**No. of cases**	**Percentage**
No complications	15	75%
Superficial infection	2	10%
Knee stiffness	1	5%
Post op Knee Pain	2	10%
DVT	Nil	Nil

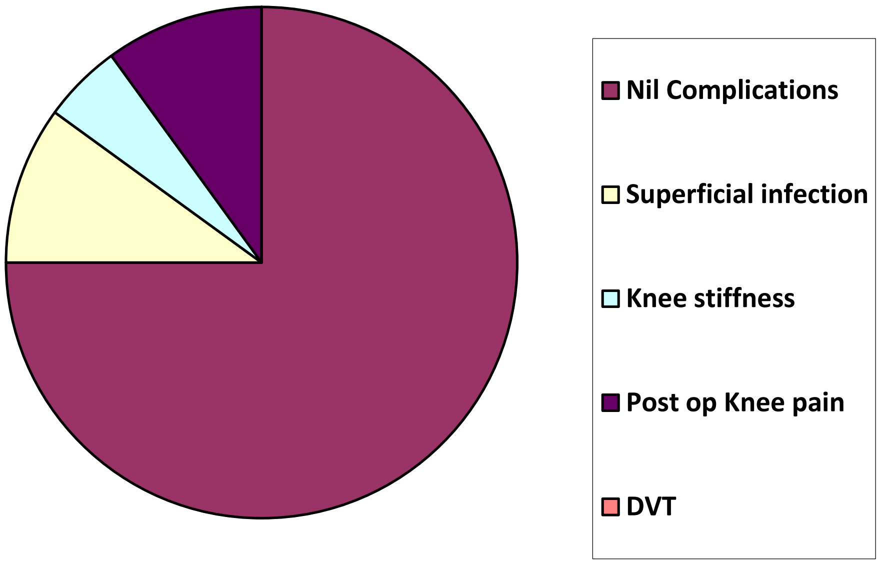


Figure 37 – Distribution of Complication

DISCUSSION

DISCUSSION

The proximal tibial plateau fractures are associated with poor functional outcome if not treated successfully[27]. Proximal tibial plateau fractures account for about 2 % of all the fractures. The management of these fractures have evolved significantly over the past decades. There are no clear-cut guidelines for non-operative treatment and across all patient ages and activity levels, many consider that articular step-off of less than 3 mm or condylar widening of less than 5 mm tends to have an acceptably low rate of adverse long-term effects if treated nonoperatively. With varus or valgus tilt, the functional outcome deteriorate steadily. Age is never considered a criteria since older individuals do better when treated properly.

In 19th century, it was believed that posteromedial tibial plateau fracture was rare. and difficult to treat. Advent of CT scan and 3-D reconstruction unveiled the posteromedial fragment in many cases of tibial plateau fractures. The incidence of this posteromedial fragment was found to be 33% in all cases of bicondylar proximal tibial fractures by a study done by Barei et al. In a study by Higgins et al[28]., he analysed the CT scans of bicondylar tibial plateau fractures (111 cases) and found the incidence of posteromedial fragment to be 59% (65 cases). It is believed that the posteromedial fragment.. occurs as a consequence of avulsion of semimembranosus tendon attachment of the proximal tibia due to hyperextension force. It may also occur as a result of the varus force on a flexed knee causing the femoral condyle to impact on the tibial plateau resulting in split fracture. The unique feature of the posteromedial fragment is that it has a relatively large surface area forming almost half of the surface area on the medial condyle. In a study by Barie et al[29]., it contributed for about 58%(

range 9%-98%) of the surface area of medial condyle of proximal tibia. Higgins et al., confirmed the fact and showed that the fragment occupied 25% of the total tibial articular surface. Usually it is a split fracture with more than 5mm displacement rather than a depression even in osteoporotic bones. As a result there have poor outcome after conservative treatment. It is often associated with injury to anterior cruciate ligament. Open reduction and internal fixation with buttress plating is the recent recommendation for these fractures. Since the fragment is postero-medial, the direct posterior approach placed the neurovascular structures at risk. Approaching the fragment anteriorly also posed risks in the form of extensive dissection of the medial capsular structures and needed tibial tubercle osteotomy for better exposure. In a study by Hsieh et al., they used anteromedial approach and advocated it since there is no risk of neurovascular injury or flexion contracture of the knee[30]. This approach involved erasure of semi-membranosus and semi-tendinosus tendons. The medial collateral ligament was also easily injury. Since the major blood supply of knee is from the medial side there is increased risk of soft tissue devitalisation in already compromised soft tissue from high velocity injury. In 1960s, posterior approach to knee involving dissection of the neurovascular bundle was introduced by Trickey[31]. Since it was a highly demanding procedure, many had complications.

Bendayan et al described a posteromedial second incision. to reduce and stabilize a displaced posterior fragment[32]. Direct visualization and satisfactory reduction were achieved. Injury of the medial head of gastrocnemicus was an unavoidable complication. Anteroposterior lag screws were applied to hold the fracture fragment. Hsieh et al., in their study involving 8 cases treated using anteroposterior lag screws showed satisfactory results. But the stabilisation of the large fragment with anteroposterior screws showed to be biomechanically unstable. Some suggested long screws in the lateral locking plates to hold the fragment in place. But the direction of the screws were parallel to the fracture plane rendering them biomechanically inferior to posteromedial locking plates. Moreover the direction of screws in the locking plates were fixed. The incidence of varus collapse and the subsequent poor functional outcome was associated with lateral locking plates used for this type of fracture.

Yoo et al in his study found that the 3.5 mm nonlocking lateral tibial plate combined with a 1/3rd tubular plate in the posteromedial aspect was biomechanically superior[33].

In our study, fractures involving the medial condyle of the proximal tibia especially with the posteromedial fragment were treated with 3.5 mm system posteromedial locking compression plate. Functional outcome was measured using Lysholm Knee Score system which evaluates 8 parameters and rates the patient's experience with a score in each section. The combined score is taken with maximum score of 100. Outcome graded into excellent,good fair and poor based on the scores. The outcome was comparable with other studies with excellent outcome in 14 patients, good outcome in 5 cases and one case with fair outcome.

Grade	No. of cases	Percentage
Excellent	14	70%
Good	5	25%
Poor	1	5%
Fair	0	0%

Study	No of cases	Union	Outcome			No. of cases with complications
			Excellent	Good	Fair	
Hong-wei Chen et al	36	12 weeks	21	13	2	3cases
Lobben hoffer and P Gerich T Bertram	21	10 weeks	12	8	1	3 cases
Brever R, Lewis CP, D Copas	13	8 weeks	7	4	2	1 case
Chen Z Dia Z et al	18	10weeks	12	4	2	Nil
Our study	20	9.7 weeks	14	5	1	3cases

LIMITATIONS OF THE STUDY

The sample size was comparable to other studies and the statistical significance can only be drawn with large sample size in a descriptive study. Our study has a relatively short follow-up and it was not a randomized control study.

CONCLUSION

CONCLUSION

The study emphasizes the importance of the postero-medial fragment in the management of the tibial plateau fractures. 80 % of the mechanical load is being transferred to the concave congruent medial condyle. So accurate reduction and buttressing the fragment is essential for excellent functional outcome. Newer three column concept of the proximal tibia by Luo et al signifies the importance of the posteromedial and posterolateral corners of the knee joint[15]. The goal of treatment of these fractures aims at stability and perfect articular reduction, both of them are not possible without reduction and fixation of the posteromedial fragment.

With the advent of better imaging modalities like CT, the incidence of the fracture has increased. Computed tomography is essential in all cases of complex tibial plateau fractures and guides the management. It is now shown that the fractures of the posteromedial portion of the medial condyle of proximal tibia are not uncommon. Open reduction and internal fixation of the fragments with preferable a low profile plate is always indicated.

The posteromedial approach being the safe one need to be used without any complications. Anterior approach warrants excessive soft tissue dissection and the direct posterior approach needs dissection through neurovascular bundle[34]. Posteromedial approach is not associated any such complications. Thorough anatomy of the posteromedial portion of the knee is important.

Lateral locking plates alone cannot achieve maintenance of fracture reduction and are often associated with varus collapse and decreased functional outcome.

Antero-posterior lag screws are also insufficient in holding onto the reduced fragments. Posteromedial plate is biomechanically superior to the available implants.

Fixation of the posteromedial tibia allows for early rehabilitation of the patient and has excellent function outcome with less incidence of complications. A well-planned approach to the tibial plateau fracture with importance to the posteromedial fragment has excellent functional outcomes.

CASE ILLUSTRATIONS

CASE ILLUSTRATIONS

CASE 1

38 years male presented with Type IV schatzker Fracture Proximal tibia after a history of RTA. He was treated with Posteromedial locking compression plate.

Figure 38.a - Represents Pre-operative X-ray of the patient.

Figure 38.b, 38.c and 38.d show the intra-operative pictures

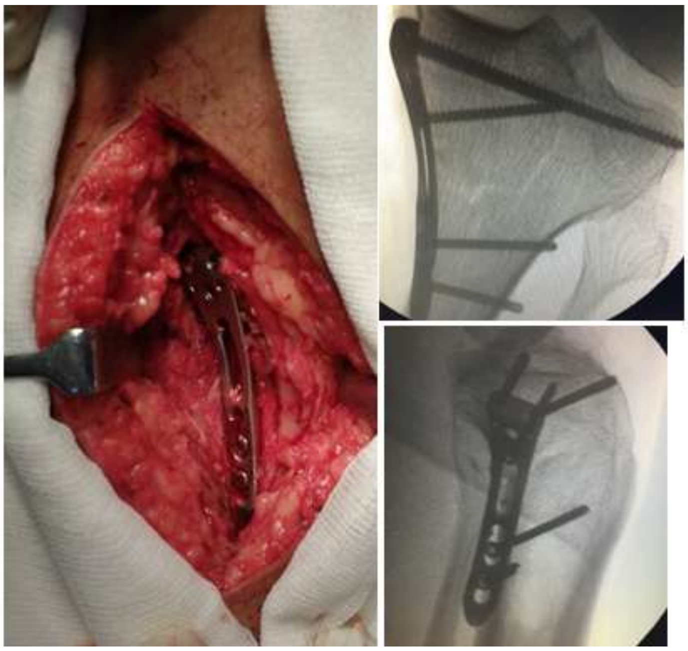


Figure 38.e, 38.f and 38.g represents immediate, 1 month, 3months Post-operative X-rays respectively.

Figure 38.h - Showing 6 months follow up X-ray

Figure 38.i - Showing Clinical Photo

CASE 2

38 years male presented with type 5 schatzker after a history of road traffic accident.

Following pictures are the pre op CT and X-ray of the patient.

Figure 39.a – Preop Xray and CT

Figure 39.b - Immediate post op X-ray

Figure 39.c - One month post op X-ray

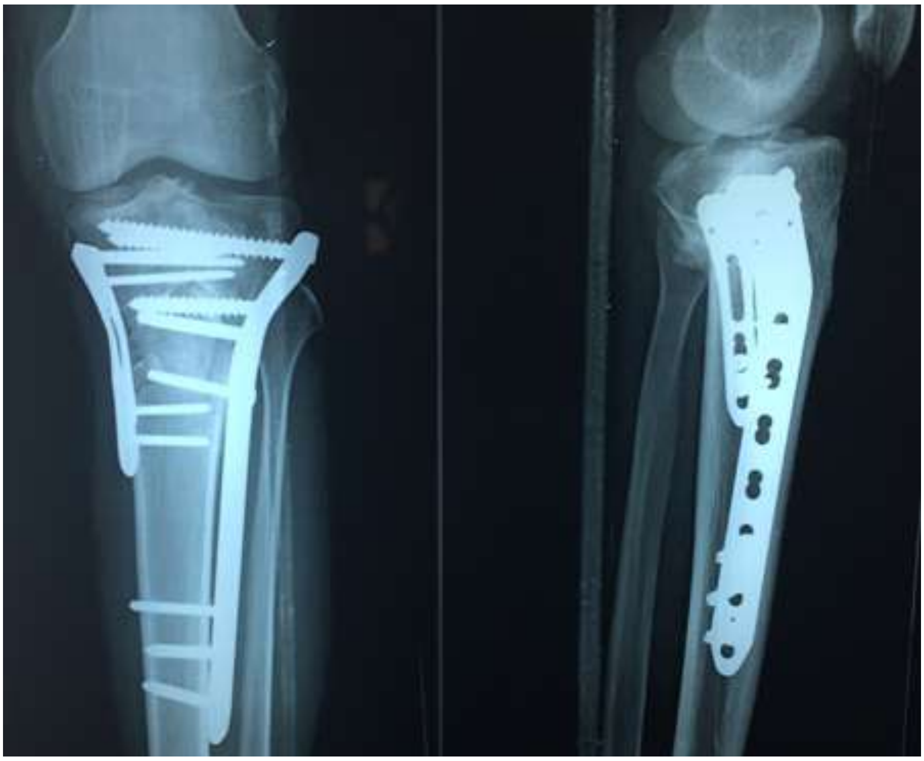


Figure 39.d - 3 months and 6 months follow up X-rays

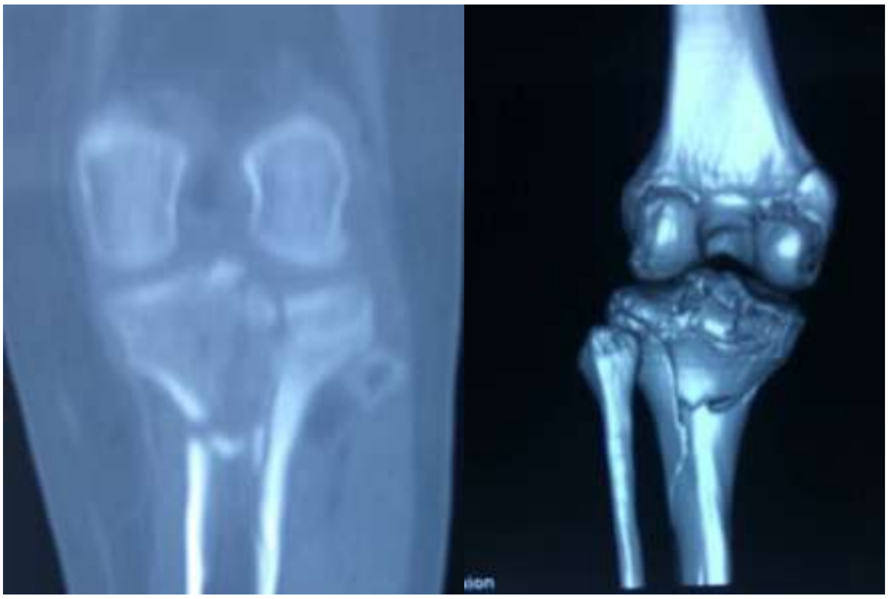
Clinical photo

CASE 3

24 years male with history of Road traffic accident presented with type V schatzker proximal tibia. He was managed with bicondylar plating- Anterolateral locking plate for lateral condyle and posteromedial plating for medial condyle.

Figure 40.a and 40.b Showing preop CT and X-ray showing type V schatzker fracture of proximal tibia.

a)



b)

Figure 40.c – Showing Intraop C-arm pictures

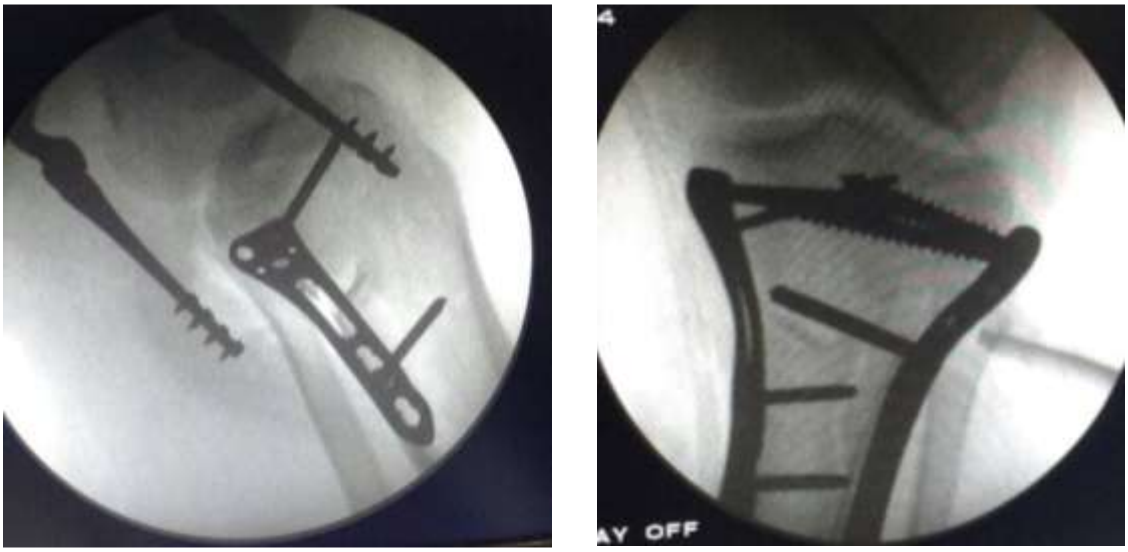


Figure – 40.d - Immediate post op

Figure - 40.e Three months post op

Figure – 40.f - Six months post op

Figure 40.g - Clinical photo

CASE 4

42 years old male sustained injury after Road traffic accident presented with medial condyle fracture of proximal tibia.

Figure 41.a to 41.d showing Fracture of Posteromedial Fragment.

Figure 41.e, 41.f and 41.g showing immediate, one month and 6 months follow up X-rays respectively

Figure 41.e, 41.f, 41.g, Showing Follow up x-rays

(e)

(f)

(g)

Figure 41.h - Clinical Photo at 6 months

CASE 5

30 years old male presented with type 4 schatzker fracture of proximal tibia. Fig a to d showing medial condyle fracture.

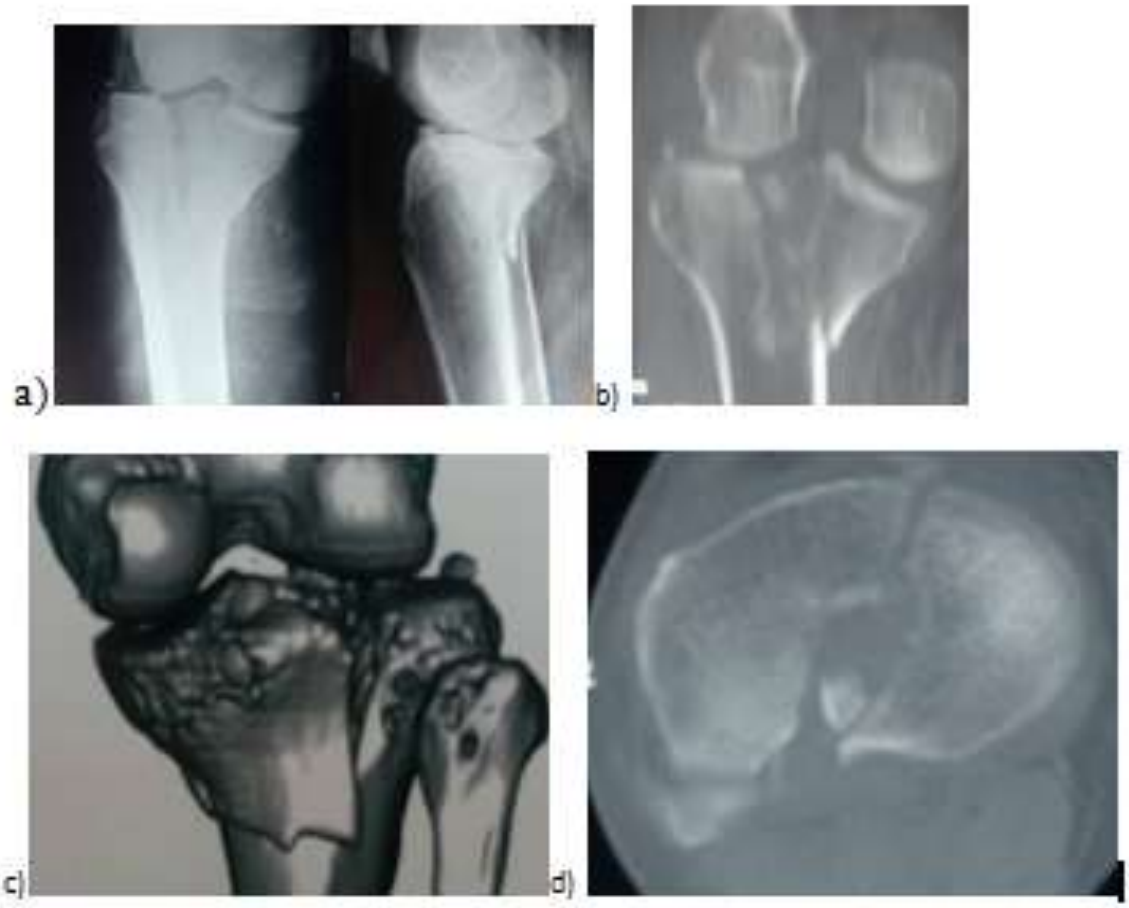


Figure 42.a to 42.d Showing Preop X-rays and CT.

The case treated by posteromedial approach to proximal tibia by Posteromedial locking plate and and a cancellous screw.

(e) (f)

(g) (h)

Figure 42.e to 42.i Showing Follow up X-rays and Clinical Pictures.

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BIBLIOGRAPHY

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LYSHOLM KNEE SCORING SYSTEM

SECTION 1 – LIMP

- I have no limp when I walk. (5)
- I have a slight or periodical limp when I walk. (3)
- I have a severe and constant limp when I walk. (0)

SECTION 2 - SUPPORT

- Using cane or crutches I do not use a cane or crutches. (5)
- I use a cane or crutches with some weight-bearing. (2)
- Putting weight on my hurt leg is impossible. (0)

SECTION 3 - LOCKING SENSATION IN THE KNEE

- I have no locking and no catching sensation in my knee. (15)
- I have catching sensation but no locking sensation in my knee. (10)
- My knee locks occasionally. (6)
- My knee locks frequently. (2)
- My knee feels locked at this moment. (0)

SECTION 4 - GIVING WAY SENSATION FROM THE KNEE

- My knee gives way. (25)
- My knee rarely gives way, only during athletics or vigorous activity. (20)
- My knee frequently gives way during athletics or other vigorous activities. In turn I am unable to participate in these activities. (15)
- My knee frequently gives way during daily activities. (10)
- My knee often gives way during daily activities. (5)
- My knee gives way every step I take. (0)

SECTION 5 – PAIN

- I have no pain in my knee. (25)
- I have intermittent or slight pain in my knee during vigorous activities. (20)
- I have marked pain in my knee during vigorous activities. (15)
- I have marked pain in my knee during or after walking more than 1 mile. (10)
- I have marked pain in my knee during or after walking less than 1 mile. (5)
- I have constant pain in my knee. (0)

SECTION 6 – SWELLING

- I have swelling in my knee. (10)
- I have swelling in my knee on1y after vigorous activities. (6)
- I have swelling in my knee after ordinary activities. (2)
- I have swelling constantly in my knee. (0)

SECTION 7 – CLIMBING STAIRS

- I have no problems climbing stairs. (l0)
- I have slight problems climbing stairs. (6)
- I can climb stairs only one at a time. (2)
- Climbing stairs is impossible for me. (0)

SECTION 8 – SQUATTING

- I have no problems squatting. (5)
- I have slight problems squatting. (4)
- I cannot squat beyond a 90deg. Bend in my knee. (1)
- Squatting is impossible because of my knee. (0)

GRADING OF LYSHOLM KNEE SCORE

<65	Poor
65-83	Fair
84-90	Good
>90	Excellent

ANNEXURES

PATIENT PROFORMA

DATA COLLECTION

Patient's Name :

Age:

Sex:

Occupation:

Address:

Contact no:

I.P.No:

Date of admission:

Date of surgery:

Date of discharge:

History of Injury:

Investigations:

- Radiological : Plain X-ray of Knee Joint –anteroposterior & lateral views
- CT knee joint
- MRI knee joint
- Complete hemogram
- Renal function test
- Bleeding time & Clotting time

- Screening for infections - HIV, HBV, HCV, Syphilis
- Chest X-ray & Electrocardiogram

Diagnosis:

Treatment:

Post-operative protocol:

- Knee immobilisation in brace
- Quadriceps strengthening and active assisted exercise

Follow up:

Date	**Clinical status**	**X-ray findings**	**Lysholm score**
Immediate post op			NA
One month			
Three months			
Six months			
Nine months			

TAMIL CONSENT FORM

நோயாளிஒப்புதல்படிவம்

ஆராய்ச்சியின்விவரம்:

ஆராய்ச்சிமையம்:

நோயாளியின்பெயர்: நோயாளியின்வயது:

பதிவுஎண்:

நோயாளிகீழ்கண்டவற்றுள்கட்டங்களை (✔)செய்யவும்

1. மேற்குறிப்பிட்டுள்ளஆராய்ச்சியின்நோக்கத்தையும்பயனையும்முழுவதுமாகபுரிந்துகொண்டேன். மேலும்எனதுஅனைத்துசந்தேகங்களையும்கேட்டுஅதற்கானவிளக்கங்களையும்தெளிவுபடுத்திக்கொண்டேன்.

2. மேலும்இந்தஆராய்ச்சிக்குஎனதுசொந்தவிருப்பத்தின்பேரில்பங்கேற்கிறேன்என்றும்,மேலும்எந்தநேரத்திலும்எவ்விதமுன்னறிவிப்புமின்றிஇந்தஆராய்ச்சியிலிருந்துவிலகமுழுமையானஉரிமைஉள்ளதையும், இதற்குஎவ்விதசட்டபிணைப்பும்இல்லைஎன்பதையும்அறிவேன்.

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சிஉதவியாளரோ, ஆராய்ச்சிஉபயத்தாரோ, ஆராய்ச்சிபேராசிரியரோ,ஒழுங்குநெறிசெயற்குழுஉறுப்பினர்களோஎப்போதுவேண்டுமானாலும்எனதுஅனுமதியின்றிஎனதுஉள்நோயாளிபதிவுகளைஇந்தஆராய்ச்சிக்காகவோஅல்லதுஎதிர்காலபிறஆராய்ச்சிகளுக்காகவோபயன்படுத்திக்கொள்ளலாம்என்றும்,
மேலும்இந்தஒப்பந்தனைநான்இவ்வாராய்ச்சியிலிருந்துவிலகினாலும்தகும்என்றும்ஒப்புக்கொள்கிறேன்.
ஆயினும்எனதுஅடையாளம்சம்பந்தப்பட்டஎந்தபதிவுகளும்
(சட்டபூர்வமானதேவைகள்தவிர)வெளியிடப்படமாட்டாதுஎன்றஉறுதிமொழியின்பெயரில்இந்தஆராய்ச்சியிலிருந்துகிடைக்கப்பெறும்முடிவுகளைவெளியிடமறுப்புதெறிவிக்கமாட்டேன்என்றுஉறுதியளிக்கின்றேன்.

4. இந்தஆராய்ச்சிக்குதான்முழுமனதுடன்சம்மதிக்கின்றேன்என்றும்மேலும்ஆராய்ச்சிக்குழுவினர்எனக்குஅளிக்கும்அறிவுரைகளைதவறாதுபின்பற்றுவேன்என்றும்இந்தஆராய்ச்சிகாலம்முழுவதும்எனதுஉடல்நிலையில்ஏதேனும்மாற்றமோஅல்லதுஎதிர்பாராதபாதகமானவிளைவோஏற்படுமாயின்உடனடியாகஆராய்ச்சிகுழுவினரைஅணுகுவேன்என்றும்உறுதியளிக்கின்றேன்.

5. இந்தஆராய்ச்சிக்குத்தேவைப்படும்அனைத்துமருத்துவப்பரிசோதனைகளுக்கும்ஒத்துழைப்புதருவேன்என்றுஉறுதியளிக்கின்றேன்.

6. இந்தஆராய்ச்சிக்குயாருடையவற்புறுத்தலுமின்றிஎனதுசொந்தவிருப்பத்தின்பேரிலும்சுயஅறிவுடனும்முழுமனதுடனும்சம்மத்திக்கின்றேன்என்றுஇதன்மூலம்ஒப்புக்கொள்கிறேன்.

நோயாளியின்கையொப்பம் / பெருவிரல்கைரேகைஆராய்ச்சியாளரின்கையொப்பம்

இடம்: தேதி:

ETHICAL COMMITTEE CLEARANCE CERTIFICATE

INSTITUTIONAL ETHICS COMMITTEE
GOVT. KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Protocol ID. No. 78/2018 Meeting held on 12.03.2018

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "FUNCTIONAL OUTCOME OF MEDIAL CONDYLE FRACTURES OF PROXIMAL TIBIA TREATED USING POSTEROMEDIAL LOCKING COMPRESSION PLATE "submitted by Dr.K.Durairaj, Post Graduate in Orthopeadics, Govt. Royapettah Hospital / Kilpauk Medical College, Chennai.

The Proposal is **APPROVED.**

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

DEAN
Govt. Kilpauk Medical College,
Chennai-10.

ME I Sec> Ethical Committee

MASTER CHART

S.No	Name	Age	Sex	History	Side	Diagnosis	Surgery	Blood loss	ROM	UNION	LK score	Outcome	Complications
1	Thangaguru	24	M	RTA	R	Type VI	L + PM	105 ml	130 deg	10 weeks	92	Excellent	Nil
2	Arun	34	M	RTA	R	Type V	L+PM	90 ml	130 deg	10 weeks	94	Excellent	Nil
3	Ashok kumar	26	M	FALL FROM HEIGHT	L	Type IV	PM+ 6.5mm CC Screw	40 ml	120 deg	8 weeks	92	Excellent	Nil
4	Devendran	37	M	RTA	R	Type V	L+PM	110 ml	110 deg	12 weeks	86	Good	Nil
5	Parthiben	46	M	SELFFA LL	R	Type V	L+PM+ BG	140 ml	140 deg	8weeks	94	Excellent	Nil
6	Villallan	44	M	SELFFA LL	R	Type IV	PM	40 ml	140 deg	8weeks	96	Excellent	Nil
7	Govindammal	62	F	SELFFA LL	L	Type IV	PM	60 ml	130 deg	8weeks	94	Excellent	Nil
8	Murali	41	M	RTA	R	Type IV	PM	45 ml	140 deg	8 weeks	96	Excellent	Nil
9	Prakash	24	M	RTA	R	Type VI	L+PM	120 ml	140 deg	8 weeks	92	Excellent	Nil
10	Jayagandhi	48	F	SELFFA LL	R	Type V	L+PM	90 ml	120 deg	10 weeks	84	Good	Superficial infection
11	Siddharthan	43	M	RTA	L	Type IV	PM	60 ml	130 deg	8 weeks	94	Excellent	Nil
12	Saravanan	39	M	RTA	R	Type VI	L+PM+ BG	130 ml	120 deg	12 weeks	86	Good	Nil
13	Anthonyraj	48	M	FALL FROM HEIGTH	L	Type V	L+PM	90 ml	110 deg	12 weeks	84	Good	Superficial infection

14	Ranjith	28	M	SELFFALL	L	Type IV	PM	60 ml	130 deg	10 weeks	92	Excellent	Nil
15	Jayanthi	34	F	RTA	R	Type V	L+PM	110 ml	110 deg	12 weeks	86	Good	Nil
16	Sasikumar	52	M	RTA	R	Type VI	L+PM	120 ml	90 deg	12 weeks	82	Fair	Knee Stiffness
17	Prem kumar	23	M	RTA	R	Type IV	PM	60 ml	140 deg	8weeks	94	Excellent	Nil
18	Selvi	40	F	SELFFALL	L	Type IV	PM	70 ml	130 deg	10weeks	92	Excellent	Nil
19	Anbarasan	28	M	RTA	R	Type V	PM+6.5 mm CC SCREW	110 ml	130 deg	8weeks	94	Excellent	Nil
20	Prabhakaran	27	M	RTA	L	Type IV	L+PM	40 ml	140 deg	8weeks	94	Excellent	Nil

LEGEND FOR MASTER-CHART

S.No	-	Serial number
M	-	Male
F	-	Female
RTA	-	Road Traffic Accident
L	-	Left
R	-	Right
PM	-	Posteromedial Plating
L	-	Lateral Buttress Plating
CC	-	Cannullated Cancellous
ROM	-	Range Of Motion
Deg	-	Degree
LK score	-	Lysholm Knee Score